

Mine Health and Safety Council



“EFFECTS OF CANNABIS ON OCCUPATIONAL HEALTH AND SAFETY IN THE SAMI AND BENCHMARK FOR MAXIMUM ALLOWABLE BLOOD LEVEL OF CANNABIS AT THE WORKPLACE”

Final Report

**Wilson, K., Mhura, D., Mbenenge, K., Nemuramba, K.,
Van Tonder, N., Mhura, M.**

Research agency:	Mundele Business Consultancy
Project number:	CoE 210101
Date:	23 May 2025
Version:	2

Table of Contents

LIST OF FIGURES	iv
LIST OF TABLES	vi
ABBREVIATIONS AND NOMENCLATURE	vii
ACKNOWLEDGEMENTS	viii
EXECUTIVE SUMMARY	ix
1 PROJECT BACKGROUND AND INTRODUCTION.....	16
1.1 Background.....	16
1.2 Problem statement	17
1.3 Research Objective	18
Research questions	18
Research sub-questions	18
1.4 Project Milestones	19
1.5 Chapter Conclusion.....	19
2 PROJECT METHODOLOGY	20
2.1 Introduction	20
2.2 Research design	20
2.3 Research approach.....	20
Approach for Milestone 1	21
Approach for Milestone 2	21
Approach for Milestone 3	23
Approach for Milestone 4	29
Approach for Milestone 5	30
Approach for Milestone 6	31
2.4 Research validity and reliability	32
2.5 Ethical considerations	32
2.6 Limitations and delimitations	33
2.7 Significance of the study	33
2.8 Chapter Conclusion.....	34
3 PROJECT RESULTS AND OUTCOMES	34
3.1 MILESTONE 1	34
Results and Outcomes for Milestone1	34
Conclusions from Milestone1	35

3.2	MILESTONE 2	35
	Results and Outcomes for Milestone 2	35
	Conclusions from Milestone 2	77
3.3	MILESTONE 3	78
	Results and Outcomes per Milestone 3	78
	Conclusions from Milestone 3	115
3.4	MILESTONE 4	116
	Results and Outcomes per Milestone	116
	Conclusions from Milestone 4	138
3.5	MILESTONE 5	138
	Results and Outcomes for Milestone 5	138
	Conclusions from Milestone 5	145
3.6	MILESTONE 6	147
	Results and Outcomes per Milestone 6	147
	PART A – THE GUIDELINE	147
1.	FOREWORD	147
2.	OBJECTIVE OF THE GUIDELINE	149
3.	SCOPE OF THE GUIDELINE	149
4.	DEFINITIONS AND ACRONYMS	150
	PART B – PROPOSED UPDATES TO THE CODE OF PRACTICE (COP)	151
1.	COP ON THE MINIMUM STANDARDS TO PERFORM WORK AT A MINE	151
	PART C – GUIDANCE FOR CANNABIS TESTING AND ASSESSMENT	151
1.	ALCOHOL AND SUBSTANCE ABUSE POLICY	151
1.3.	Allowable cut-off limits of THC	152
2.	EMPLOYMENT CONTRACTUAL REQUIREMENTS	152
3.	CONTRACTORS AND VISITORS	153
4.	CANNABIS TESTING PROCEDURES AND ASSESSMENT TOOLS	154
4.4.	Cannabis screening	154
4.5.	Cannabis detection	155
4.6.	Cannabis confirmation	156
5.	CANNABIS SURVEILANCE AND MONITORING	157
5.	Initial examinations	157
6.	Periodic/routine/ongoing surveillance and monitoring	158
	PART D – IMPLEMENTATION	160

1.	IMPLEMENTATION PLAN	160
2.	COMPLIANCE WITH THE GUIDELINE	160
3.	ACCESS TO THE GUIDELINE	160
	Conclusions from Milestone 6	161
4	CONCLUSIONS.....	161
5	LESSONS LEARNED	161
6	RECOMMENDATIONS	162
6.1	Recommendations for further research	162
6.2	Recommendations for implementation for the sector	162
7	REFERENCES.....	164

LIST OF FIGURES

Figure 1 Scoping review flow diagram.	23
Figure 2 Proposed sample organisations	26
Figure 3 Mine employer and employee representatives	26
Figure 4 Results by organisations type	81
Figure 5 Results by designation type	81
Figure 6 Results categorised by number of years' work experience	82
Figure 7 Designation representation by organisations type	83
Figure 8 Designation representation by work experience.....	84
Figure 9 Awareness of cannabis legislation	85
Figure 10 Opinion about impact of cannabis decriminalisation on OHS	85
Figure 11 Opinion of cannabis impact on OHS by designation.....	86
Figure 12 OHS attitude by organisations type.....	88
Figure 13 Organisational attitude towards OHS by designation	89
Figure 14 Number of accidents/incidents since cannabis decriminalisation	90
Figure 15 Cannabis awareness and training	91
Figure 16 Cannabis awareness and training by organisations type	91
Figure 17 Cannabis awareness and training by designation.....	92
Figure 18 Drug policy and assessment procedures awareness	93
Figure 19 Revision of drug policies and procedures	94
Figure 20 Affirmation of drug policies and procedures revision.....	94
Figure 21 Perspectives about the adequacy of existing drug policies and procedures.....	95
Figure 22 Adequacy of drug testing policies and procedures by designation	96
Figure 23 Adequacy of drug testing policies and procedures by work experience	96
Figure 24 Should the standard drug policies and procedures be revised?.....	97
Figure 25 Drug policy revision by organisations type	98
Figure 26 Drug policy revision by designation.....	99
Figure 27 Drug policy revision by work experience	99
Figure 28 Awareness of the existing drug assessment tools and procedures.....	100
Figure 29 Effectiveness of the existing drug assessment tools and procedures.....	101
Figure 30 Effectiveness of existing drug assessment tools by work experience.....	102
Figure 31 Effectiveness of existing drug assessment tools by work experience.....	103
Figure 32 Should the drug assessment tools and procedures be revised?	103

Figure 33 Revision of drug assessment tools and procedures by designation	104
Figure 34 Change in employment policies	105
Figure 35 Employment policy revision by organisations type	106
Figure 36 Forest plot of pooled ORs	121
Figure 37 Meta-analysis pooling of aggregate data	122

LIST OF TABLES

Table 1 Population	24
Table 2 Champion mines	25
Table 3 Cannabis use categories	53
Table 4 Recreational cannabis	55
Table 5 Half-life of cannabis	59
Table 6 Detection period by test type	71
Table 7 Planned vs actual sample representation	79
Table 8 Key data variables	79
Table 9 Organisational attitude towards OHS since cannabis decriminalisation	87
Table 10 Study characteristics	118
Table 11 Source effects (Odds Ratios) and 95% CI	120
Table 12 Summary of THC cut-off limits	132
Table 13 USA per se THC laws	133
Table 14 Europe per se THC laws	134
Table 15 Fining THC blood levels in Denmark	135

ABBREVIATIONS AND NOMENCLATURE

CI	Confidence Interval
ConCourt	Constitution Court of South Africa
COP	Code of Practice
CPP	Cannabis for Private Purpose Act No. 7 of 2024
DMRE	Department of Mineral Resources and Energy
EAP	Employee Assistance Program
EEA	Employment Equity Act No. 55 of 1998
LRA	Labor Relation Act No. 66 of 1995
MHSA	Mine Health and Safety Act No. 29 of 1996
MHSC	Mine Health and Safety Council
MCSA	Minerals Council South Africa
MIPAS	Mining industry professional associations
MS	Microsoft
NRTA	National Road Traffic Act No. 93 of 1996
OHS	Occupational Health and Safety
OHS Act	Occupational Health and Safety Act No. 85 of 1993
OHP	Occupational Health Practitioner
OMP	Occupational Medical Practitioner
ORs	Odds Ratios
PDTC	Program Delivery Technical Committee
PRISMA	Preferred Reporting Items for Systematic Reviews and Meta-Analyses
RSVP	Répondez S'il Vous Plaît
SAMI	South African Mining Industry
SIMRAC	Safety in Mines Research Advisory Committee
THC	Δ^9 -tetrahydrocannabinol
ToR	Terms of Reference

ACKNOWLEDGEMENTS

The authors would like to thank the following persons or institutions for their valuable contributions during the research project:

- The MHSC for sponsoring the research.
- Members of the PDTC and the SIMRAC for guidance.
- Dr Nonhlanhla Tlotleng for guidance and support throughout the research process.
- Dr Khumbi Nemuramba for the meta-analysis.
- Dr Kerry Wilson for the literature review and benchmarking exercise
- Trudi du Toit for the presentations at the industry stakeholders' workshop.
- The project technical reviewers

EXECUTIVE SUMMARY

Introduction

In 2018, the Constitution Court of South Africa decriminalised the use, possession, and cultivation of cannabis in private spaces following a series of litigations related to human rights infringement. Section 2 of the Cannabis for Private Purpose Act 7 of 2024 (CPP) allows an adult to possess or use cannabis in a private place and for private purposes. Empirical evidence suggests that cannabis use may potentially be associated with impairment in cognition, such as memory loss, psychomotor, and the executive functioning of the brain, which can impact reflex abilities and lead to injuries, accidents or even deaths (Campeny et al., 2020). Since cannabis falls under the umbrella of intoxicating drugs or substances, its decriminalisation has a bearing on workplace productivity and general health and safety in the South African Mining Industry (SAMI).

However, The CPP statute did not provide any guidance on how it should be treated in the workplace thereby creating a gap in interpretation and application for drug assessments and testing by the SAMI. Furthermore, literature shows that cannabis has an extended half-life, remaining in the body much longer compared to other substances, regardless of intoxication levels (Ashley et al., 2020). The presence of cannabis in the body does not necessarily imply that the user is under its influence, which renders some of the existing drug testing and assessment methods currently used in the SAMI inadequate requiring additional guidance.

Employers in the SAMI have provisions to uphold the health and safety of workers. This includes prohibiting any employee who is or appears to be under the influence of any intoxicating liquor or drugs from entering or remaining at work, in accordance with Section 2 of the Occupational Health and Safety Act 85 of 1993. Additionally, Schedule 8, Section 3(1) of the Labour Relations Act No. 66 of 1995 (LRA) maintains that employers must generate rules of standard conduct required of their employees. Schedule 8, Section 7 of the LRA further asserts that dismissal is not unfair if it relates to misconduct which is stipulated in the pre-defined code of practice. Based on this

legal framework, employers in the SAMI implemented zero tolerance for alcohol and drug abuse in the workplace.

Nevertheless, the strict enforcement of zero-tolerance drug policies in the workplace, particularly regarding cannabis, was recently challenged legally following the dismissal of employees who had tested positive for cannabis. This challenge was on the basis that the employer could not prove impairment or incapacity to perform duties.

Thus, it became necessary to conduct a research study aimed at providing legal certainty on the allowable blood limits of cannabis in the body that shall not pose a safety risk to the employee or others in the SAMI workplace. This study would also provide guidance on the testing and assessment methods that should be used for cannabis.

Aim and objectives of the study

The scope of this research study was to conduct a comprehensive literature review on cannabis and its effects in relation to workplace safety, assess industry stakeholders' perspectives in the SAMI sector regarding the impact of cannabis decriminalisation on occupational health and safety policies, and establish acceptable blood thresholds for cannabis use in the workplace. The findings were then presented to the mining industry stakeholders at a workshop where extensive discussions resulted in additional inputs that led to the formulation of the guidance document for testing and assessing the allowable limits of cannabis use while at work in the SAMI.

Research methodology

To achieve the objectives of this study, a pragmatic research design was utilised in which a mixed methods approach was applied to collect, analyse and interpret the data for the study. For the literature, a scoping review, systematic review and meta-analysis of odds ratios (ORs) based on the PRISMA principles were utilised. Data synthesis and analysis were conducted using the STATA v18.5 software. An exploratory approach was used to solicit inputs from the industry stakeholders through a questionnaire which gathered both quantitative and qualitative data. The results were analysed using triangulation, descriptive statistics, and comparative statistics.

The workshop with industry stakeholders was highly interactive with in-depth discussions in a hybrid model that had options for physical or virtual participation. The data from all these activities were then synthesized resulting in a guidance document. The validity, reliability, ethical considerations, limitations, delimitations and the significance of the study were considered.

Literature Review

In this section of the study, the literature reviewed covered various aspects, including cannabis legislation, definitions, uses, effects, impact on workplace safety and productivity and testing. It was established that the full impact of cannabis use on workplace productivity and safety in the mining industry is yet to be determined and quantified and should therefore be researched further. The countries which legalised cannabis did not provide guidelines for its management in the workplace. Nevertheless, cannabis remains a drug with psychoactive properties that might pose a risk to workplace productivity and safety if not managed adequately particularly in the SAMI due to the hazardous nature of the work.

Although the benefits of cannabis are widely documented, the potential negative impact on employee productivity and general safety in the workplace cannot be underestimated. It was further determined in the literature that the traditional ways of assessing and testing for the presence of drugs in the workplace are inadequate for cannabis and that there are no alternative guidelines on how testing should be done. It became clear that the SAMI needed to devise strategies to manage cannabis and maintain health, safety and productivity in the workplace while upholding the human right provisions.

Survey on perspectives about cannabis decriminalisation

The industry stakeholders provided their perspectives about cannabis decriminalisation and the impact on the existing drug testing and assessment methods. The general perspective was that cannabis decriminalisation had negative implications for occupational health and health in the SAMI and that action should be taken to address it. Most of them confirmed that there was not enough training and awareness about

cannabis and its impact for workplace safety. They also confirmed that there had not been any revisions to the existing employment policies or the policies around drug testing since cannabis was decriminalised.

There was no clear consensus on whether the existing drug testing policies and assessment procedures in the SAMI are sufficient to cover cannabis or if they need revision. Similarly, there was no clear indication of whether the existing assessment tools and procedures currently used to detect the presence of drugs on employees in the SAMI are effective enough for cannabis. This was a clear indication of a need for further guidance on how to proceed.

Benchmarking of allowable limits of cannabis

The results of the meta-analysis of ORs showed that Delta9-tetrahydrocannabinol (THC) blood concentration levels of less than 1 ng/ml are insignificant and do not pose a safety risk to the health of individuals (Laumon et al., 2005). However, THC blood levels of 1 ng/ml and above had a dose-effect causal role which weakens the capacities thereby posing a potential health and safety risk to cannabis users (Laumon et al., 2005; Gadegbeku et al., 2011). At THC blood levels of 1 ng/ml, impairment is mild, worsening steadily with additional dosage such that considerable impairment is evident at THC blood levels of 2 ng/ml and above.

Based on the evidence from the systematic review of literature and meta-analysis of ORs for this study and given the per se limits for cannabis use that have been implemented globally, it was recommended that the SAMI implements the following maximum allowable limits of cannabis use:

- i. **1 ng/ml** blood THC concentration limits for any employee who works in dangerous environments or is involved in handling of machinery, equipment, vehicles, and any movable objects as part of their daily duties while in the workplace.
- ii. **2 ng/ml** blood THC concentration limits for any employee who is office bound and their daily duties do not involve handling of machinery, equipment, vehicles, and any movable objects in the workplace.

Workshop with the mining industry stakeholders

The in-depth discussions led to consensus on several items of contention. One major item related to cannabis testing tools, processes, and procedures. The general impression was that there was lack of clarity on the effectiveness of the existing practices for drug testing to cover cannabis. Eventually, it was concluded that the existing drug testing and assessment methods were adequate for cannabis although more clarity was required regarding the implementation of the allowable blood limits of cannabis at work. A suggestion was made to use the law of contract as a strategy to implement the allowable limits of cannabis in the SAMI.

Additionally, a risk-based approach to screening for cannabis was proposed. However, it was emphasized that the rules for drug screening and testing should be applied consistently across all types of drugs and alcohol monitoring to ensure uninterrupted health and safety of employees daily. Mandatory medical tests for cannabis should predominantly be used to determine fitness to work, while daily screening for cannabis should be meant to remove employees who are impaired from the workplace to ensure the health and safety of all employees.

The other issue related to the misconceptions around impairment testing. It was clarified that impairment testing is already conducted in cases of suspected intoxication, although it was agreed that more research is required to understand latest technologies for impairment testing to align with the global trends.

The Guidance Document

The knowledge synthesis resulted in new guidelines for testing and assessing the allowable limits of cannabis use in the workplace. Firstly, the code of conduct in the existing alcohol and substance abuse policy should be updated to include the allowable blood cut-off limits of THC concentration in the body while at work. Furthermore, the employment contract should be updated to specify the terms and conditions around cannabis testing procedures ensuring that employees understand the implications of non-compliance and adhere accordingly.

The terms and conditions pertaining to cannabis testing must be referenced in the contractual agreement between the mining companies and the contractors. Visitors to a mine must be informed about the cannabis provisions and that they can be screened and tested if suspected of intoxication.

It is recommended that the policy be updated to make it compulsory for employees to declare if they are using cannabis for medicinal purposes, or any other purposes, or if they are taking prescription medicine that could influence the cannabis test outcomes. This declaration should be done prior to the test and not retrospectively, after a positive test result. Additionally, employers should revise their Employee Assistance Programs (EAP) to specify cannabis support and increase training and awareness of the impact of cannabis on mental health and workplace safety.

The existing drug testing process consisting of screening, detecting, and confirming should apply to cannabis. Screening should be conducted by qualified personnel such as the Occupational Medical Practitioners (OMP) or Occupational Health Nurses (OHN) and should include techniques such as sobriety testing, impairment testing, and other observational tactics. Detecting cannabis should be conducted through clinical chemistry techniques using non-invasive and semi-invasive tools for testing urine, oral fluid, hair, sweat or nails. To confirm cannabis use, blood samples should be collected by a qualified health practitioner such as a phlebotomist. These samples must be appropriately stored and transported to a certified laboratory for analysis.

Throughout the process of cannabis testing, detailed documentation should be maintained showing every screening, detection, and confirmation outcome. The surveillance and monitoring of cannabis will follow the existing risk-based framework for exposure consisting of initial and periodic/routine/ongoing examinations. Other than the standard drug tests conducted during the initial medical assessments to derive baseline medical information, the baseline information should incorporate historical use of cannabis, including the mental health condition, the purpose for using, the frequency of use, and the age of first use. All this information should be obtained and assessed.

Outside of the standard prescribed periodic medical surveillance, the frequency of routine surveillance and ongoing monitoring for cannabis should be risk-based as determined by the baseline information and should be related to the nature of work and the working environment. For work or environments deemed dangerous or work responsibility that could result in financial, operational, or commercial loss, cannabis surveillance and monitoring should be conducted more frequently than in other types of working environments. Additionally, the mandatory code of practice on the minimum standards of fitness to perform work at a mine should be updated to include provisions related to the employment contract.

Conclusions

To address the problem statement identified for this research project, a robust research methodology was implemented. This included a comprehensive review of the literature on cannabis legislation, definitions, uses, effects on workplace safety and productivity, and testing in the workplace. This was followed by a survey to understand the perspectives of industry stakeholders about cannabis decriminalisation and the impact on the existing drug testing and assessment methods.

A significant part of this process was to benchmark the allowable limits of cannabis use. This process provided clear cannabis limits for specific work categories that should be implemented in the SAMI. The research findings were presented back to the industry stakeholders for enrichment towards the eventual development of a guidance document for testing and assessing the allowable limits of cannabis use in the workplace that should be adopted by the SAMI.

Overall, the methods used in this research study yielded the intended result which is to provide guidance on the management of cannabis in the SAMI.

1 PROJECT BACKGROUND AND INTRODUCTION

1.1 Background

Historically, cannabis production, processing, trading, and use had been criminalised in South Africa under various statutes, including the Medicine and Related Substances Act No. 101 of 1965, the Medical Dental and Pharmacy Act No. 13 of 1928, the Abuse of Dependence-producing Substances and Rehabilitation Centres Act No. 41 of 1971, the Drugs and Drug Trafficking Act No.140 of 1992 and the Customs and Exercise Duty Act No. 27 of 1992. These statutes were duly enforceable prior to 1994, when there was no legal basis for human rights to challenge the status quo.

However, a new constitution was implemented in 1996 aimed at fostering the Bill of Rights, which was adopted through the Constitution of the Republic of South Africa Act No. 108 of 1996. The constitution was subsequently utilised to challenge the previous legislations around cannabis criminalisation based on the Bill of Rights including its application in relation to workplace safety. Following a series of litigations in 2018, the Constitution Court of South Africa (ConCourt) decriminalised the use, possession, and cultivation of cannabis in private. Section 2 of the Cannabis for Private Purpose Act No. 7 of 2024 (CPP) allows an adult to possess or use cannabis in their private place and for private purposes.

The decriminalisation of cannabis for private use in South Africa is the first of its kind in the rest of Africa and amongst the few other nations globally that have done so over the last decade. In terms of occupational health and safety, cannabis falls under the umbrella of intoxicating drugs or substances and therefore the decriminalisation has a bearing on its implications for productivity and general health and safety in the workplace. Empirical evidence suggests that cannabis use may potentially be associated with impairment in cognition, such as memory loss and psychomotor and executive functioning of the brain, which can impact reflex abilities and lead to injuries, accidents, or even deaths (Campeny et al., 2020).

Due to the recent decriminalisation of cannabis, clear guiding principles and standards for its management in the workplace have yet to be established and published for application in different industries globally.

1.2 Problem statement

The CPP statute in South Africa only clarified the possession or use of cannabis in one's private space and capacity but did not clarify how it should be treated in the workplace thereby creating a gap in interpretation and application for occupational health and safety. It is noteworthy that cannabis contains intricate chemical compounds known as cannabinoids whose metabolites linger in the body much longer compared to other substances, regardless of intoxication levels (Ashley et al., 2020).

This complicates drug testing in the workplace because the presence of cannabis in the body does not necessarily imply that the user is under its influence. This renders some of the existing drug testing and assessment methods currently used in the workplace inadequate for cannabis thereby requiring additional guidance on its management.

In terms of Section 2 of the Occupational Health and Safety Act 85 of 1993 (OSHA), it is the duty of employers to uphold health and safety of workers including prohibiting any employee who is or appears to be under the influence of any intoxicating liquor or drugs from entering or remaining at work.

The legal framework is further supported by the Labour Relations Act No. 66 of 1995 (LRA), specifically Schedule 8, s3(1) which mandates employers to establish rules defining the expected standard of conduct for employees to mitigate unfair dismissal. According to Section 7 of Schedule 8 of the LRA, dismissal is considered fair if it relates to misconduct and aligns with the predefined code of good practice outlined in the company policies. Based on this requirement, employers in the South African Mining Industry (SAMI) have implemented zero tolerance for alcohol and drug abuse in the workplace, which is duly enforceable based on the provisions of the LRA.

Nevertheless, recent litigations have challenged the broad application of zero tolerance policy for drug use in the workplace, especially regarding cannabis, arguing the principle of fairness in terms of dismissals. Such litigations include the Enever v Barloworld Case No. JS 633/20 and JS926/20 and the Mthembu & others v NCT Durban Wood Chips [2019] 4 BALR 369, in which employees were dismissed for testing positive for cannabis even though the employers could not prove that they were under the influence and incapacitated to perform their individual duties. Employers must now prove that an individual was under the influence and unable to perform their duties safely when

instituting a disciplinary action against employees resulting from a positive drug test results. These actions highlighted shortcomings in the existing drug and substance abuse testing and assessment standards and processes in relation to the management of cannabis in the workplace.

1.3 Research Objective

The primary objective of this research study is to develop a set of guidelines for testing and assessing the allowable blood limits of cannabis use in the workplace to be adopted in the SAMI.

Research questions

To achieve the primary objective of the study the following question was constructed:

“What are the effects of cannabis on occupational health and safety in the SAMI and what is the maximum allowable blood limit of cannabis in the body at the workplace?”

Research sub-questions

To answer the research question for the study, it was required that the following specific research questions be addressed:

1. According to the local and international literature, what is the use of cannabis and its effects in relation to workplace safety, considering the following components:
 - a. Effects of use of cannabis on people and duration of the effects on the body?
 - b. Different uses of cannabis?
 - c. Testing for cannabis using invasive and non-invasive methods?
 - d. How does the use of cannabis affect the safety and productivity of employees?
 - e. The legislation and changes to the legislation around cannabis?
2. What are the perspectives of the SAMI stakeholders about the decriminalisation of cannabis and its effect on policies?
3. What is the allowable blood level of cannabis in the body, determined using non-invasive assessments and assessment tools, that will clarify when a person using cannabis for various purposes shall pose a safety risk to him or herself or others in the workplace?

4. What are the guidelines for testing and assessing the allowable blood limits of cannabis use in the SAMI workplace?

1.4 Project Milestones

The following were the milestones for this research project

1. Project initiation.
2. A comprehensive literature review on the use of cannabis and its effects in relation to workplace safety.
3. A survey of the industry stakeholders in the SAMI to determine their perspectives on the decriminalisation of cannabis use and the effect on occupational health and safety policies.
4. A benchmarking exercise to determine the allowable blood level of cannabis in the body, using invasive and non-invasive assessments and assessment tools, that will clarify when a person using cannabis for various purposes shall pose a safety risk to him or herself or others in the workplace.
5. A workshop with the industry stakeholders to discuss the findings of the research study and to solicit their input.
6. A guidance document or a set of rules for the testing and assessment of allowable blood levels or limits of cannabis use and its effects on the workplace to be used by the SAMI.
7. Draft Final Report encapsulating the outcomes of the project
8. Final Report Inclusive of Webpage Summary
9. Publishable manuscript, technical handover to the MHSC and project closure

1.5 Chapter Conclusion

In this chapter, the research study has been clearly introduced by articulating the background detailing the chronology of events that led to the initiation of this research project. The problem statement has been further enunciated, elaborating on the critical issues that need to be addressed for the study. Bases on the gaps identified in the problem statement, the research question has been formulated along with the objectives of the study aimed at addressing the primary objective of this study. Additionally, a step-by-step listing of the milestones planned to deliver on each specific objective has been set out.

2 PROJECT METHODOLOGY

2.1 Introduction

The concept of planning is described by Beauregard (2020), as a continuous decision-making process that identifies and helps define a focus that results in achieving the desired outcomes. It is unusual that much is achieved without proper planning which is guided by a specific design that provides a compass for the way ahead.

Similarly, this research study was not conducted in a vacuum but was rather planned and framed within a specific research paradigm (Pham, 2018). The research paradigm was presented from a particular perspective using specific approaches and techniques describing the way the research was conducted to deliver data, analysis and findings that are suited to the research purpose and solve the research problem.

2.2 Research design

The overarching research design utilised for this study was pragmatism which is fundamentally premised on practical ways of investigating the reality of a phenomenon. At its core, pragmatism is a philosophy where research design makes use of the practical operational decisions that are based on what will work best in a real-world situations as opposed to idealistic or non-practical theoretical solutions (Kelly & Cordeiro, 2020).

Pragmatism as a research design was justified for this study because it favors theories embedded in practicalities and views knowledge as the reality that is derived from real world experiences with solutions that can solve real world problems (Maarouf, 2019). One of the strengths of pragmatism suggested by Maarouf (2019) is that it enables the researcher to incorporate different facets to the problem in a single study through holistic analysis of all relevant impacts thereby enhancing the validity of the study and rendering the results generalizable to other contexts. For this study, pragmatism would be achieved through consultations with the SAMI stakeholders to enrich the research findings with practical solutions.

2.3 Research approach

The mixed method approach was utilised for this research study. This approach to research entails a deliberate combination of both the qualitative and quantitative

research methods in the collection, analysis and interpretation of data for a given study (Tomaszewski, 2020, Rutberg & Bouikidis, 2018, Goertzen, 2017). The intentional mixing of research methods presents researchers with a divergent view of their research and their research questions answered at a much deeper and enriched level (Rutberg & Bouikidis, 2018).

The most notable advantage of the mixed method approach, according to Rutberg & Bouikidis (2018), is the increase in the validity and reliability of the study as the disadvantages of either the qualitative or quantitative methods are cancelled out. The use of this approach, which is premised on pragmatism, will enable the researcher to address the research question due to its inherent quality of objectivity, reliability, and validity (Rutberg & Bouikidis, 2018).

For this study, the different approaches applied to each milestone are discussed in the subsections below.

Approach for Milestone 1

The aim of milestone 1 was to present to the Program Delivery Technical Committee (PDTC) and Safety in Mines Research Advisory Committee (SIMRAC), a project execution plan outlining the overall project scope as well as the quality, technical and contractual specifications of the project. To gather this information, the research approach was largely qualitative in nature through consultative discussions with the relevant stakeholders conducted through face to face, email, and telephone. The information gathered was then consolidated into a PowerPoint presentation that was presented to the project sponsors.

Approach for Milestone 2

The aim of milestone 2 was to conduct a comprehensive literature review, nationally and internationally, on the use of cannabis and its effects in relation to workplace safety. To achieve this, the scoping review approach was used as a method to identify knowledge gaps in the literature relating to the management of cannabis in the workplace and to clarify concepts around cannabis legislation, effects, intoxication, testing, and different uses.

According to Munn et al., (2018), scoping review is used where the purpose of the review is to identify knowledge gaps and clarify concepts or to investigate research conduct in such a manner that is rigorous and transparent. This approach ensures that only the relevant, reliable, valid, and applicable literature aimed at addressing the research question is analysed, evaluated, synthesized, and included in the review (Snyder, 2019). **Figure 1** below presents the process flow taken in the scoping review for this milestone in the research.

As presented in Figure 1, the scoping review commenced with the search of potential literature from different sources including, Science Direct, PubMed, Google scholar and Web of science databases as well as government legislation, court cases and other internet sources. Specific key word strategies were used such as single words or phrases like AND, OR, NOT operators, where applicable, to narrow the search output as closely related to the desired result as possible. The search yielded a total number of 20,382 results across all subtopics for the study which were reduced to 571 articles upon initial screening and removing articles which were either duplicate records, or deemed ineligible, or unrelated to the current study and removed for other reasons.

Further screening of the articles resulted in a total number of 163 being included in the study after the rest had been excluded due to irretrievability, not being related to workplace safety, not related to the mining industry or occupational safety, of low quality and whose scientific methods could not be applied in the current study. The literature included in the study consisted of scientific studies, reports, government legislation, court cases and other sources over the last 10 years.

Scoping review flow diagram

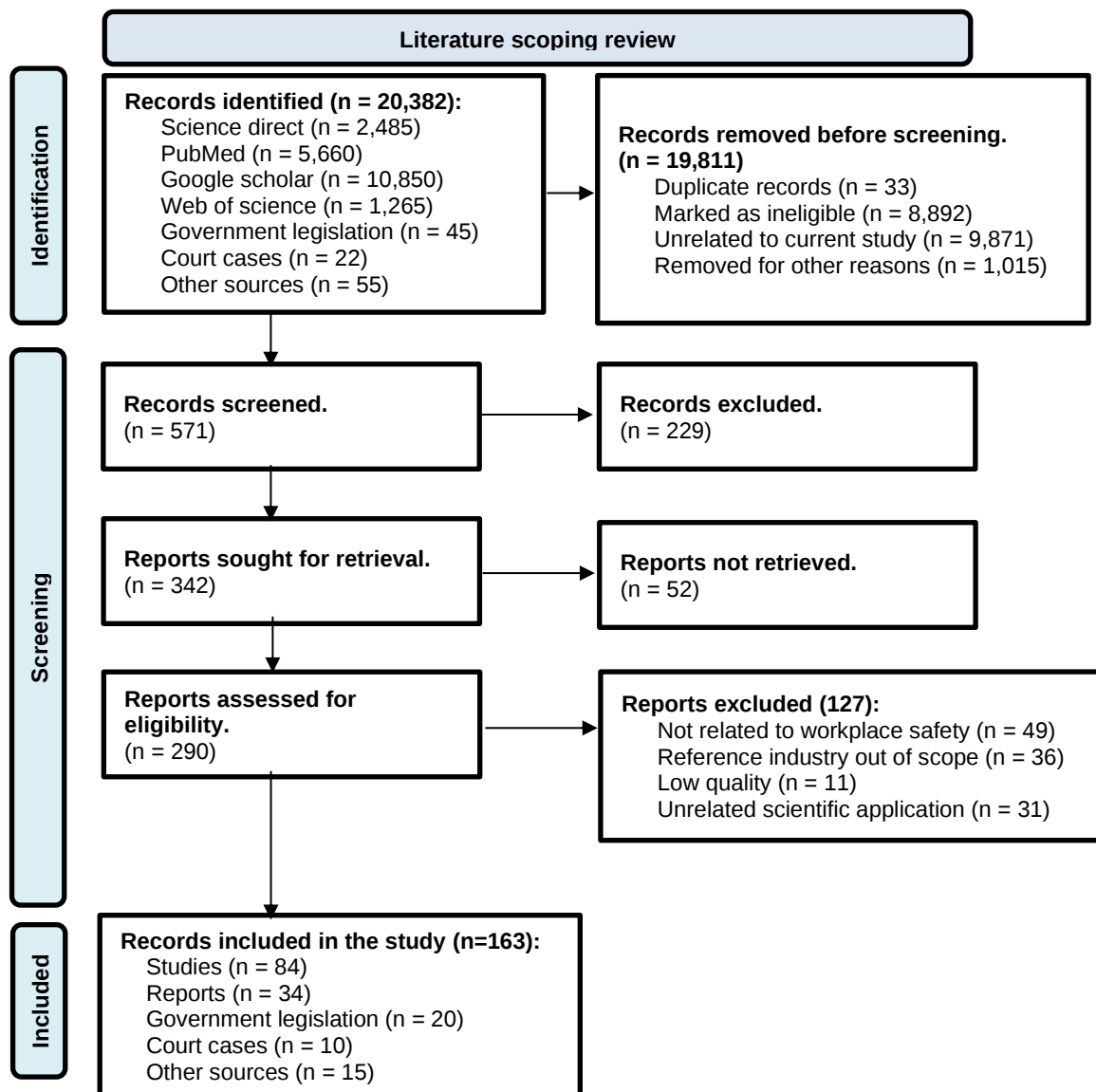


Figure 1 Scoping review flow diagram.

Source: Adopted from Page et al., (2021)

Approach for Milestone 3

The aim of milestone 3 was to conduct a survey on the perspectives of the stakeholders in the SAMI about the decriminalisation of cannabis use and the effect on the policies. To achieve this, the exploratory research approach was used to gather the information required from the industry stakeholders. According to Saunders, Lewis & Thornhill (2019), exploratory research is an approach used to investigate a problem which is not clearly known, which was justified by the fact that the perspectives of industry stakeholders about cannabis decriminalisation was unknown at that point in time. For

this exploratory study, the data type was mostly quantitative with qualitative qualifiers for enhanced quality of objectivity, measurability, reliability, and validity with very little room for subjectivity (Ryan 2018).

This research approach was appropriate for addressing the requirement of this milestone due to the precariousness of recreational cannabis and its impact on occupational health and safety in the SAMI. The survey collected information profiling the respondents, their opinion about cannabis decriminalisation and its impact on policies and procedures in the workplace.

Population and Sample

The target population for the study was prescribed in the Terms of Reference (ToR) for this research project as being organisations and entities, which have strategic partnerships within the SAMI. This broad scope of strategic partnerships was further broken down into specific organisations as shown in **Table 1** below.

Table 1 Population

#	Target Population	Specific organisations and entities
1	South African (SA) government	Department of Mineral Resources and Energy (DMRE)
		Mine Health and Safety Council (MHSC)
		Mining Qualifications Authority
		Department of Health
		Department of Employment and Labour
2	Organised labour	Solidarity
		Association of Mineworkers and Construction Union
		National Union of Mineworkers
		National Union of Metalworkers of South Africa
		United Association of South Africa Trade Union
		Metal and Electrical Workers Union of South Africa
3	Organised business	Minerals Council South Africa (MCSA)
		Aggregate and Sand Producers Association of Southern Africa
4	Mining industry professional associations (MIPAs)	Association of Mine Safety Professionals of South Africa
		Association of Mine Managers of South Africa
		Association of Mine Resident Engineers
		Association of Mining Industry Human Resource Practitioners

		Mine Medical Professionals' Association
		Mine Metallurgical Managers' Association
		Mines Professional Associations' Secretariat
		Mine Ventilation Society of South Africa
		South African Institute of Occupational Safety and Health
		South African National Institute of Rock Engineering
		South African Colliery Environment Safety and Health Association
5	Mining companies	Employer representatives including senior and middle management
		Employee representatives including the workforce, miners, production supervisors and mine overseers

The champion mines are presented in **Table 2** below:

Table 2 Champion mines

Commodity	#	Mine	Owner	Mine Type	Province
Gold	1	South Deep mine	Gold Fields	Underground	Gauteng
	2	Tshepong mine	Harmony Gold	Underground	Gauteng
Platinum	3	Marikana (Lonmin) mine	Sibanye Stillwater	Underground	Northwest
	4	Mogalakwena	Anglo American	Open Cast	Limpopo
Coal	5	Syferfontein mine	Sasol	Underground	Mpumalanga
	6	Khutala mine	Seriti Resources	Underground	Mpumalanga
Diamond	7	Cullinan mine	Petra Diamonds	Underground	Gauteng
	8	Venetia mine	De Beers	Open Cast	Limpopo
Copper	9	Phalaborwa Mine	Rio Tinto	Open Cast	Limpopo
Coal	10	Grootegeluk Mine	Exxaro	Open Cast	Limpopo

The sample size had been determined using representative matrices based on the prescribed population as a total number of 194 participants consisting of the organisations and employer and employee representatives as presented in **Figures 2 and 3** below respectively.

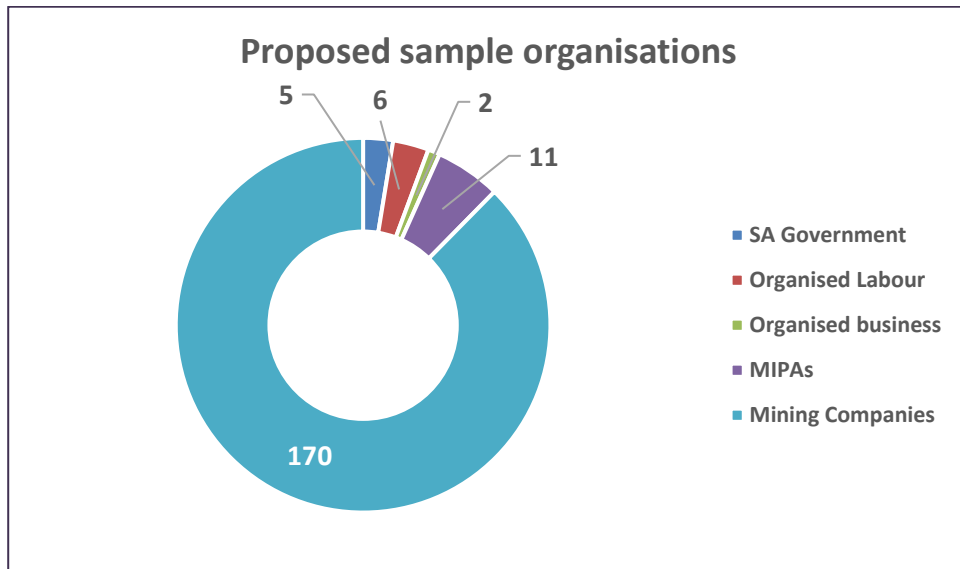


Figure 2 Proposed sample organisations

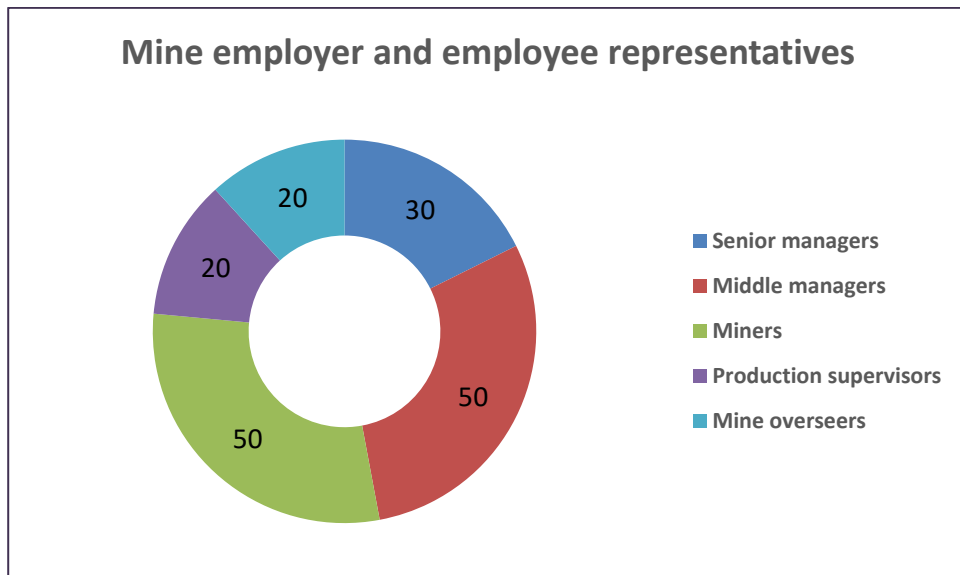


Figure 3 Mine employer and employee representatives

Survey instrument

The data for this study was collected using the “Data Collection Framework” or questionnaire attached to this report as **Appendix 8.1**. The questionnaire was developed based on expert guidance on the expected output and was piloted with the MHSC delivery experts. The questionnaire was classified under the following subsections:

- Profile of participating stakeholders.
- Opinions about cannabis decriminalisation and its impact on policy.
- Workshop invitation.

The section on the profile of the stakeholders who participated in the survey was used to identify the type of organisations represented, including SA government, organised labour, organised business, academia, MIPAs, mining companies and others. This section also solicited information on the designation of the participants such as Occupational Health Practitioner (OHP), Occupational Medical Practitioner (OMP), organisations spokesperson, executive manager, senior manager, middle manager, production supervisor, mine overseer, mine worker, and others. Additionally, the information on the duration of time that participants had held their current designations was collected categorised as less than 2 years, between 2 and 5 years, between 5 and 10 years, and over 10 years. Collecting the profiles of participants was necessary to accurately discern the statistical insights from the data for correct interpretation and recommendations.

The sections on participants' opinions were designed to solicit information about the following:

- Whether the participants were aware of cannabis decriminalisation and its impact on occupational health and safety and productivity in the workplace.
- Whether the number of incidents or accidents had increased since cannabis decriminalisation and if there was enough awareness and training on cannabis and workplace safety in the SAMI.
- Whether the drug testing policies, assessment tools and procedures, and employment policies had been revised since cannabis was decriminalised.
- Whether participants thought that the existing policies, procedures, and assessment tools were adequate to effectively address cannabis-related issues, and what needed to change if they were not adequate.

The information gathered from the section on opinions about cannabis decriminalisation was used to gauge the understanding and perspectives of stakeholders regarding the impact of cannabis on occupational health and safety policies and procedures in the SAMI.

The purpose of the workshop invitation section was twofold: firstly, to inform the participants of the imminent workshop to be conducted in the subsequent months to share and discuss the research findings and solicit their inputs to enrich the recommendations for cannabis management; secondly, to build a database of

stakeholders who wish to participate in the upcoming workshop by providing attendance options (either physically or virtually) and requesting voluntary contact information for formal invitations.

Data collection method

The primary mode of data collection utilised was the electronic SurveyMonkey software platform. This platform was chosen for its ability to generate a questionnaire with electronic links for emails, social media posts, pop-ups, and web links. These links were used to solicit participation through email invitations, link posts on the researcher's Facebook and LinkedIn pages, website, and WhatsApp links shared widely with all potential participants.

Participation in the survey was voluntary, and the recruitment process began with the sharing of an introductory letter issued by the MHSC. This letter, attached to this report as **Appendix 8.2**, allowed the researcher to approach potential participants and request for participation. Only after the participants had agreed to take the survey was the questionnaire sent to them for completion. The initial survey message generated by SurveyMonkey and subsequent follow-up survey prompts are attached to this report as **Appendix 8.3**.

To encourage broader participation and eliminate restrictions associated with disclosing identifiers such as the name of the organisations and individuals, the survey was anonymous. However, the internet protocol address was enabled to provide unique identification of devices used in the data collection process, including desktops, tablets, and smartphones.

Data processing

The data was collected between 29 March 2024 and 2 May 2024, achieving a response rate of over 100%. Once all the data was collected, individual responses were extracted, consolidated and submitted to the MHSC separately. All the variables were considered as per the data collection framework. There was neither transformation of the data nor pre-coding of any datasets for this study. The qualitative data obtained in the form of comments from participants is presented in this report as extracted from the original form.

The data collected was analysed using the following statistical techniques:

- Frequency distribution method was used to understand how frequently an outcome was favoured by participants to deduce commonality of response.
- Triangulation was used on the comments obtained during the survey to deduce meaning in the quantitative choice options made for specific data variables.
- Inference statistics method was used to infer specific opinions of the SAMI stakeholders about cannabis legislation based on the distribution of key variables for the study.
- Comparative statistics method was used to compare datasets across opinions and profiles represented in the sample to determine consistency and validity amongst them.

Approach for Milestone 4

The aim of milestone 4 was to conduct a benchmarking exercise to determine the allowable blood level of cannabis in the body, using invasive and non-invasive assessments and assessment tools, that would clarify as to when a person using cannabis for various purposes, would pose a safety risk to themselves or others in the workplace. To achieve this, a systematic review of the available literature was conducted along with a meta-analysis of the Odds Ratios (ORs) to pool the studies that had shown risk thresholds for cannabis use and suggested the cut-off blood limits for safety and intoxication or impairment and the probability of accidents.

The systematic review and meta-analysis of ORs was conducted in accordance with the Preferred Reporting Items for Systematic Reviews and Meta-Analyses (PRISMA) 2020 Framework (Page et al., 2021). The PRISMA framework was appropriate for this milestone to enable clear eligibility of the data included in the meta-analysis and a systematic screening process for literature on cannabis.

Searches were conducted in different sources including Science Direct, PubMed, Google Scholar and Web of Science databases. Search terms utilised included specific keyword strategies related to the primary topic of cannabis limits, intoxication, odds, and dose-effect relationships. Single words or phrases using AND, OR, NOT operators were used where applicable to narrow the search output as closely related to the desired result as possible. Databases were searched from the year 2000 through to 2024. The reference lists of included studies were also searched for additional studies or relevance.

For the meta-analysis, studies were included if they specifically showed the odds or probability of accidents at different thresholds of cannabis use, where limits had been presented in nanograms per milliliter (ml). The studies included were those which had investigated the association of Δ^9 -tetrahydrocannabinol (THC) usage with impairment and the odds for accidents. Additionally, studies were included if they were a case-control or prospective case study design, if they included effect estimates such as ORs with Confidence Intervals of 95% (95% CI) and if they had utilised logistic regression to derive the ORs. Studies were excluded if they did not include specific cut-off limits to show the odds of accidents at different doses.

Once identified, each study was screened to remove duplicates, studies marked as illegible and studies unrelated to the current meta-analysis. The quality of the included studies was assessed and reviewed by an independent reviewer. All relevant studies identified were included in the meta-analysis, regardless of their methodological quality.

The data from the studies included were extracted into a standardised Microsoft (MS) excel file created specifically for this review. Data extracted from each study included general information such as year of publication, geographical setting, study design and biomarker. There was no categorisation of any variables as they were extracted in their original format. All the studies included in this meta-analysis had more than one cannabis dose observation which were considered as individual case studies.

Data synthesis and analysis was conducted in STATA v.18.5 software. The dose-effect association between levels of THC use and the probability of accidents were analysed within each study cohort after which specific ORs and 95% CIs were combined across studies using common effect logistic regression. The heterogeneity statistic was estimated using a meta-analytical approach for each summary effect size to represent the heterogeneity not attributable to sample error.

Approach for Milestone 5

The aim of milestone 5 was to conduct a workshop with the industry stakeholders to discuss the findings of the research study and to solicit their input. The target population for the workshop had been prescribed in the ToR for this research project which included the following strategic partnerships in the mining industry:

- a) The South African government

- b) Organised labour
- c) Organised business
- d) The mining industry professional associations
- e) Mining companies
- f) Academia
- g) Other interested parties/persons

The workshop was a hybrid model with options for physical attendance or virtual participation. Physical attendance was conducted in a conferencing facility at Protea Hotel Midrand while the virtual live streaming was conducted using the MS Teams platform. The invitation was sent out to potential workshop attendees early in May 2024, with a (Répondez S'il Vous Plaît (RSVP)) link to google forms for them to respond to the invite. The actual invitation and google form are attached to this document as **Appendix 8.4** and **Appendix 8.5** respectively.

The invitation and RSVP link had been sent using email, WhatsApp, internet web and Facebook platforms and could be accessed and completed using these modes. The information requested on google forms was for the attendees to indicate whether they would attend in person or virtually and to provide the full name, designation, organisations represented, contact details and dietary requirements for those attending in person. This information was used for further communication and planning of the workshop.

The approach used throughout the workshop prioritised high impact interactivity for both virtual and in person participants to ensure that the content of the output would largely be shaped by the participants' discussions and contributions. Substantive attention was focused on ensuring that ample time was provisioned for comprehensive interactive engagement and in-depth discussion of the issues at hand. The outcomes of the workshop were consolidated and presented as a report.

Approach for Milestone 6

The aim of milestone 6 was to develop a guidance document or a set of rules for testing and assessing the allowable levels or limits of cannabis use and its effects on the workplace that can be utilised in the SAMI. This milestone was addressed by synthesizing the knowledge obtained from various sources including results from

previous milestones such as literature review findings, the survey results, the benchmarking exercise on the allowable blood cut-off limits of cannabis use and the outcomes of the workshop with the industry stakeholders.

2.4 Research validity and reliability

This study ensured that the external validity and reliability of the results were upheld to the highest standard possible. External validity is the degree to which conclusions in a particular study can be applied outside of the context of the study or generalized to the rest of the population (Baldwin, 2018). In this study a potential threat to the external validity that had been identified for the study was the selection bias in the composition of the SAMI stakeholders for the survey and the workshop attendance that could reduce the generalizability to the rest of the industry. To mitigate this risk, all relevant stakeholders were included to obtain the best outcome that would be applicable industrywide.

Krosnick (2018) refers to reliability firstly as the degree to which a measurement gives the same response repeatedly, secondly as the stability of a measurement over time and thirdly as the similarity of measurement within a given period. For this study, the major threat to the reliability of the research outcomes was in the allowable limits of cannabis. To mitigate the identified risk, the meta-analysis of ORs was formulated in a consistent manner such that a similar result could be obtained if administered at another time. Additionally, the various statistical methods used to analyse the survey and workshop results increased the level of reliability.

2.5 Ethical considerations

The ethical considerations in this study were guided by the following ethical principles of research by Saunders, Lewis & Thornhill (2019):

Principle #1 – Integrity, fairness and open-mindedness

During this research study, truthfulness and authenticity was maintained and the dishonesty and misrepresentation of the data and the research findings were avoided at all costs. Conflict of interest or commercial association was also declared to improve the validity of the research findings.

Principle #2 – Voluntary nature of participation and right to withdraw

As part of the data collection due diligence, voluntary participation was maintained where participants exercised the right to decide if and how they would participate in the data collection process.

Principle #3 – Ensuring confidentiality of data and maintenance of anonymity of those taking part

Although this study did not involve collecting data on personal identification of participants, anonymity was maintained such that the processed data was not attributed to individual respondents.

Principle #4 – Responsibility in the analysis of data and reporting of findings

Both primary and secondary data were used to report the findings of the study fully and accurately, irrespective of whether or not they contradicted expected outcomes.

2.6 Limitations and delimitations**The quality of data**

There was a potential challenge of the accessibility of key personnel within the SAMI stakeholders which could impact the quality of the data collected. To overcome this foreseeable challenge, reasonable attempts were made to ensure representivity of respondents who are directly involved in occupational health and safety at mining operations from all levels of responsibility and work environment.

Delimitations of the study

The scope of this study was limited to the management of cannabis as a drug in the SAMI. Be that as it may, the guidance provided for assessment and testing of cannabis could be generalized to alcohol and other substances in the workplace, particularly as human right provisions continue to challenge the existing status quo.

2.7 Significance of the study

The resultant guidance provided for assessment and testing of cannabis will have a major practical benefit of better management of alcohol and substance abuse at mining operations in the SAMI. This study provides clear guidance on the levels of cannabis that potentially causes intoxication in the body thereby enabling the industry to apply an allowable cut-off limit that is legally sound for inclusion in the law of contract. Ultimately,

this distinctive study and its resulting findings will significantly enhance the body of knowledge for the SAMI.

2.8 Chapter Conclusion

To address the research questions discussed in the introduction chapter, a supportive research methodology was implemented. This included articulating the research design and approach to each milestone of the study detailing the data collection methods, population and sampling and data analysis. The steps undertaken towards ensuring study reliability and validity have also been communicated. Ethical considerations, limitations and delimitations of the study have also been addressed along with the significance of the study.

3 PROJECT RESULTS AND OUTCOMES

3.1 MILESTONE 1

Results and Outcomes for Milestone1

As mentioned earlier, the aim of milestone 1 was to present to the PDTC and SIMRAC, a project execution plan outlining the overall project scope as well as the quality, technical and contractual specifications of the project.

The start-up presentations were conducted virtually using the MS Teams platform. The first start-up presentation was made to the PDTC at a meeting held on 10th November 2023. The actual invitation and agenda for the PDTC meeting are attached to this document as **Appendix 8.8** and **Appendix 8.9** respectively. The structure of the presentations was such that the Mundeke Business Consultancy (MBC) team was given the opportunity by the chairman of the meeting, to present the project charter on a MS PowerPoint template prescribed by the MHSC. The presentation was followed by questions and comments from the PTDC members to clarify items that were unclear and to provide inputs to enrich the project charter.

The second start-up presentation was conducted for SIMRAC at a meeting held on 5th December 2023. This presentation was the same presentation as the one presented to the PDTC but updated and enriched with comments and input from the PDTC members. The actual invitation to and presentation at the SIMRAC meeting are attached to this

document as **Appendix 8.10** and **Appendix 8.11** respectively. Similar to the PDTC meeting structure, the SIMRAC members were given an opportunity to ask questions and provide comments and inputs after MBC team had presented the project charter.

Conclusions from Milestone1

The project start-up presentations made to both the PDTC and SIMRAC showcased a detailed plan of action that MBC team would implement to successfully address the objective of the research study. It was shown that the proposed research methodology coupled with a competent project team with appropriate skills required would ensure that each component in the ToR for the research project was thoroughly addressed. The additional input from both the PDTC and SIMRAC meetings were extremely invaluable towards enriching the delivery process of this project. Overall, the initiation of Project CoE 210101 was successfully achieved which paved the way for MBC to proceed to the subsequent phases of the project.

3.2 MILESTONE 2

Results and Outcomes for Milestone 2

As indicated earlier, the aim of milestone 2 was to conduct a comprehensive literature review, nationally and internationally, on the use of cannabis and its effects in relation to workplace safety.

The literature reviewed for the study is presented under each of the following subtopics:

- Definition of cannabis
- Cannabis legislation and changes to the legislation around cannabis
- Different uses of cannabis
- Duration of the effects of cannabis on people's body
- Definition of intoxication and being under the influence of cannabis
- Effects of the use of cannabis on people in general
- The impact of cannabis on workplace safety and productivity of employees
- Testing of cannabis using non-invasive methods
- Latest trends in technology for impairment testing

3.2.1.1 Definition of cannabis

Cannabis is a plant that is widely cultivated globally and harvested in a variety of ways and processed for different uses. Cannabis is often divided into 3 species namely *Cannabis sativa*, *Cannabis indica* and *Cannabis ruderalis* (Kornpointner, Martinez, Marinovic, Haselmair-Gosch, Jamnik, Schröder, Löffke, & Halbwirth, 2021). However, *Cannabis Sativa* is the most popular species of the 3 species mainly due to its varied applications, and therefore the most documented in the literature and is referred to as cannabis for purposes of this study.

Cannabis is the general name given to a variety of plants in the cannabis family as is grown across the globe such as Marijuana (Steinmetz, 2017), Hemp (Cerino et al, 2023), Dagga (Waetjen, 2022), Mbanje (Ncube, 2017), Chambal (Bandawe, 2022), just to mention a few.

Cannabis is believed to have firstly been natively cultivated in Central or Eastern Asia over 8,000 years ago making it one of the oldest plants to have been cultivated with varied harvests ranging from seeds, flowers, leaves, the buck, and roots (Alonso-Esteban, Pineal, Ćirić, Calhelha, Soković, Ferreira, Barros, Treatises & de Cortes Sánchez-Mata, 2022). Its versatility has boosted utilisation in various industry sectors such as food, medicine, and other industrial sectors with the most research having been conducted in the medical sector according to Alonso-Esteban et al., (2022).

Within the medical sector, the research focus has been on cannabinoids which is one of the many compounds found in the cannabis plant (Alonso-Esteban et al., 2022). The most researched cannabinoids include Tetrahydrocannabinol (THC), Cannabidiol (CBD) and Cannabinol (CBN) (Kornpointner, Martinez, Marinovic, Haselmair-Gosch, Jamnik, Schröder, Löffke, & Halbwirth, 2021). These are bioactive compounds harvested mainly from flowers and leaves of a cannabis plant with THC delta 9 and 8 being the primary psychoactive component of the cannabis plant responsible for altering the function of the nervous system resulting in altered behaviour, cognition, mood, and perception in humans (Kornpointner et al., 2021).

Cannabis can be consumed in several ways inclusive of inhalation through smoking or vaporizing, oral ingestion through edibles, capsules, and infused oils, sublingually

through lozenges can be used for tropical application as lotions, salves, and oils (Alonsio-Esteban et al., 2022).

Owing to the psychoactive nature of the THC component in cannabis, it is often categorized amongst chemical substances that have the potential to breed undesirable propensities of dependency and social ill and is therefore regulated under different legislatures globally. Where cannabis is legislated, it is done so with specific directives of how cannabis should be grown, harvested, and used. Despite the legal restrictions imposed over time, cannabis is still known to be the most illegally trafficked and abused drug globally (Waetjen, 2022), warranting further understanding of different legislation particularly as it relates to workplace safety.

3.2.1.2 Cannabis legislation and changes to the legislation around cannabis

This section discusses the legislative aspects of cannabis in South Africa, the rest of Africa and the rest of the world as well as its legal implications on OHS in related jurisdictions.

Cannabis legislation in South Africa

The early legislations of cannabis in South Africa date as far back as the 1800s when the Natal's Coolie Law Consolidation prohibited the use, smoking, possession, sale, barter, or gift of any portion of the cannabis plant (Du Toit, 1991). The prohibition was implemented by the European authorities in response to the perceived negative impact of cannabis on the vitality of their workforce (Du Toit, 1991). This could be considered the first notable impact of cannabis use on OHS. Towards the late 1800, the Cape and Transvaal colonies also restricted growing and trading of cannabis as it was deemed notorious causing significant signs of moral decay amongst the users (Paterson, 2009; Chanock, 2001; Burchell, 2013). In this context, moral decay refers to the inability to distinguish the right from the wrong and could be extended to morality as it applies to OHS.

Further on in 1922, the cultivation, use, sale, and possession of cannabis was criminalized on a national level under regulation 14 of the amended Customs and Exercise Duty Act (Chanock, 2001). This regulation was enacted in response to rising illicit trade of cannabis across jurisdictions in terms of lost revenues and taxes at the time. The circumstances under which this law was passed were open to criticism due

to the discriminatory nature towards certain sectors of society and were perceived to have targeted certain racial groups (Chanock, 2001).

However, the banning of cannabis was validated in 1923 when the South African government included cannabis in the list of prohibited narcotics following the fifth session of the League of Nations Advisory Committee on Traffic in Opium and Other Dangerous Drugs (Milles, 2003). Cannabis officially got outlawed thereafter in 1925 nationally (Mills, 2003). This led to the South African government wholly criminalizing cannabis under the Medical Dental and Pharmacy Act, 1928 (Act No. 13 of 1928) stating the following in Article 69 according to Rubin (2011):

“No person shall smoke, or use, or shall import, manufacture, sell or supply, or possess for purpose of sale or supply to any person, any pipe, receptacle, or appliance for smoking opium, Indian hemp, or dagga or intsangu.”

Despite the enactment of all these laws and restrictions, the prevalence of cannabis use continued to grow in South Africa and impacting the workforce in different industry including mining due to the addictive nature of the psychotic substance in the cannabis plant. This invoked the enactment of an additional legislation of the Medicine and Related Substances Act 101 of 1965 (MRSA), also known as the Drugs Control Act, 1965, to formally regulate and control the drugs that should be intended for human consumption, inclusive of cannabis (Burchell, 2013). Another legislation named the Abuse of Dependence-producing Substances and Rehabilitation Centres Act 41 of 1971 was later enacted aimed at prohibiting the dealing in and the use or possession of the dependence-producing drugs, inclusive of cannabis (Burchell, 2013).

The other constituency of legislation that was enacted around the possession, trafficking and use of cannabis was the Drugs and Drug Trafficking Act of 1992 (DDTA) (Burchell, 2013). Under Chapter 4, sections 20 and 21 of this Act, the law defined the possession of cannabis in terms of vicinity and quantities exceeding 115 grams as a criminal offence if found guilty (Burchell, 2013). Persons found to be manufacturing, supplying, possessing, and dealing in cannabis would be criminalized under this Act.

It is noteworthy that the legislations discussed above were duly enforceable under the previous constitutions of South African prior to 1994 when there was limited legal

basis for human rights to challenge the status quo. Shortly after the democratically elected government came into effect, South Africa's new parliament implemented a new Constitutional Court of South Africa (ConCourt) meant to enforce the new constitution whose fundamental cornerstone was the Bill of Rights adopted through The Constitution of the Republic of South Africa Act 108 of 1996 (Goldstone, 1997). The constitution was subsequently utilised to challenge the previous legislations around cannabis based on the Bill of Rights including its application in relation to workplace safety. This is because the ConCourt is supreme, and its rulings and any decisions pronounced by this court cannot be overruled or changed by any other court in South Africa (Goldstone, 1997).

Although cannabis had been criminalized in South Africa, its use continued in form of medical cannabis and for religious purposes such as the Rastafarian religion who continued to be discriminated against in the workplace. Leveraging off the Bill of Rights, cannabis users took the battle of discrimination in the workplace to the courts for relief and consideration. Following a series of court cases related to the infringement of cannabis laws on human rights, the ConCourt decriminalised the use, possession, and cultivation of cannabis by an adult in private in 2018. This landmark judgment was pronounced in lieu of the following criminal cases which were heard in September 2018:

- a) Prince (Clarke and Others Intervening) v Minister of Justice and Constitutional Development (Case No. CCT 108/17).
- b) Rubin v National Director of Public Prosecutions (Case No. 7295/2013).
- c) Acton (Prince III) v National Director of Public Prosecutions (Case No. 8760/2013)

In these cases, the ConCourt upheld and extended the Western Cape High Court judgment, which had found the criminalisation of home use and cultivation of cannabis by adults, as specified in the DDTA and the MRSA unconstitutional. The court found the following provisions to be inconsistent with the ConSA:

Sections 4(b) and 5(b) of the Drugs and Drug Trafficking Act 140 of 1992 (the Drugs Act) read with Part III of Sch 2 to the Drugs Act.

- Section 4(b) dealt with the prohibition of the use or possession of cannabis by an adult in private for that adult's personal consumption in private.

- Section 5(b) dealt with the prohibition of cultivation of cannabis by an adult in a private place for that adult's personal consumption in private.

Section 22A(9)(a)(i) of the Medicines and Related Substances Control Act 101 of 1965 (the Medicines Act) and 22A (10) read with schedule 7 of GN R509 of 2003 published in terms of 22A(2) of the Medicines Act.

- Section 22A(9)(a)(i) dealt with the prohibition to acquire, use, possess, manufacture or supply cannabis by an adult in private for that adult's personal consumption in private.

It was then declared by the Deputy Chief Justice Zondo that it would not be a criminal offence for an adult to use or be in possession of cannabis in a private space for personal consumption. This was in conformity with the Bill of Rights under Chapter 2 of the ConSA related to equality (in section 9), human dignity (in section 10), freedom and security of the person (in section 12), privacy (in section 14) and freedom of religion, belief, opinion (in section 15).

Section 14 of the ConSA on privacy states as follows:

- 1) *Everyone has the right to privacy, which includes the right not to have-*
 - a. *Their person or home searched.*
 - b. *Their property searched.*
 - c. *Their possessions seized, or*
 - d. *The privacy of their communications infringed.*

Implication of Cannabis Legislation on OHS in SAMI

The decriminalisation of cannabis in South Africa for medical and recreational use only applies to its possession or use in one's private space and capacity and does not extend to the workplace. The same constitutional rights of human dignity, privacy, equality, freedom of religion, belief, opinion, and security accorded in the context of the private use of cannabis should be balanced against the health and safety principles in the workplace. The judgement was silent on cannabis in the workplace which implies that it had no impact on the existing legislation around health and safety in the workplace, particularly the Occupational Health and Safety Act 85 of 1993 (OHSA), the Mine Health and Safety Act 29 of 1996 (MHSA) and the General Safety Regulation (GSR) of the OHSA.

Under the GSR of the OHSA, the following directives are given to safeguard OHS in the workplace:

2A - Intoxication

- (1) Subject to the provisions of sub-regulation (3), an employer or a user shall not permit any person who is or who appears to be under the influence of intoxicating liquor or drugs, to enter or remain at a workplace.*
- (2) Subject to the provisions of sub-regulation (3), no person at a workplace shall be under the influence of or have in his or her possession or partake of or offer any other person intoxicating liquor or drugs.*
- (3) An employer or a user, as the case may be, shall, in the case where a person is taking medicines, only allow such person to perform duties at the workplace if the side effects of such medicine do not constitute a threat to the health or safety of the person concerned or other persons at such workplace.*

With respect to the responsibilities of employers and employees for OHS in the workplace, the OHSA makes the following directives:

Section 8 - General duties of employers to their employees

- (1) Every employer shall provide and maintain as far as is reasonably possible, a working environment that is safe and without risk to the health of the employees.*
- (2) (b) taking such steps as may be reasonably practicable to eliminate or mitigate any hazard or potential hazard . to the safety or health of employees, before resorting to personal protective equipment.*
- (d) establishing, as far as is reasonably practicable, what hazards to the health or safety of persons are attached to any work which is performed, any article or substance which is produced, processed, used, handled, stored or transported and any plant or machinery which is used in his business, and he shall, as far as is reasonably practicable, further establish what precautionary measures should be taken with respect to such work,*

article, substance, plant or machinery in order to protect the health and safety of persons, and he shall provide the necessary means to apply such precautionary measures.

(f) as far as is reasonably practical, not permitting any employee to do any work or to produce, process, use, handle, store or transport any article of substance or to operate any plant or machinery, unless the precautionary measures contemplated in paragraph (b) and (d), or any other precautionary measures which may be prescribed, have been taken.

Section 14 – General duties of employees at work

- (a) Take reasonable care for the health and safety of himself and of other persons who may be affected by his acts or omissions.*
- (c) Carry out any lawful order given to him and obey the health and safety rules and procedures laid down by his employer or by anyone authorized thereto by his employer, in the interest of health or safety.*

With respect to OHS at mining operations, the MHSA makes the following directives:

Section 7 – Employer to staff mine with due regard to health and safety

- (1) As far as reasonably practicable, every employer must -*
 - (a) Ensure that every employee complies with the requirements of this Act.*
 - (b) Institute the measures necessary to secure, maintain and enhance health and safety.*

Section 22 – Employees’ duties for health and safety.

Every employee at a mine, while at the mine, must-

- (a) Take reasonable care to protect their own health and safety.*
- (b) Take reasonable care to protect the health and safety of other persons who may be affected by any act or omission of that employee.*

For the codes of practice for the health and safety at mines, the MHSA makes the following directives:

Section 9 - Codes of practice

(1) Any employer may prepare and implement a code of practice on any matter affecting the health or safety of employees and other persons who may be directly affected by activities at the mine.

In terms of this directive, mining companies in South Africa have adopted a 'zero-tolerance' approach to the use of intoxicating substances by employees due to the dangerous nature of the work in the mining industry. This is also in line with the zero-harm mantra echoed throughout the SAMI in the processes of eliminating fatalities and hazards (Macnamara, 2023). Alco-Safe (Pty) Ltd, a partner of the Mine Medical Professionals Association recently issued statistics indicating that substance abuse is responsible for 60% of fatal accidents, 30% of domestic accidents, 50% murders and up to 40% accidents in the workplace (Evans, 2019). This shows the seriousness of the impact of substance abuse in general and in the workplace particularly to which the South African workforce is held with the highest caution.

Regardless of the constitutional courts' ruling in favour of the use of cannabis recreationally, employers are entitled to discipline employees found to be under its influence during working hours. Similar to the treatment of alcohol abuse cases, employers are permitted to act against employees who exhibit signs of impairment or inability to meet the standard of performance and care reasonably required in their specific roles due to intoxication from cannabis or any other drug substance. The authority for employers to do so is already provisioned in Section 2A of the GSR of the OHSA.

Company policy on cannabis in the SAMI

As per the provisions of the MSHA, every employer should ensure health and safety in the workplace and shall safeguard against harm and danger. In doing so, companies should implement comprehensive substance abuse policies, as a minimum, that clearly stipulate the legal aspects of positive tests for drugs such as cannabis, which all employees and unions should adhere to (Evans, 2019). A comprehensive substance abuse policy in the workplace serves as a solid framework for implementing disciplinary measures, including potential dismissal for non-compliance, which can be justified and upheld in a court of law. All employees are granted an opportunity to review the company policies on substance abuse and are given a choice to either agree or not

agree to the policy. Employees who remain employed are those who agreed to be employed under the stipulated company policies and are expected to comply. Failure to do so may result in disciplinary action or even dismissal in the case of a breach.

As a minimum, the company policy should incorporate the principles of fairness provisioned in the Labor Relation Act 66 of 1995 (LRA) and the Employment Equity Act No. 55 of 1998 (EEA), in its management of drug abuse.

Section 10 - Incapacity: Ill health or injury, of the LRA states as follows:

- 3) The degree of incapacity is relevant to the fairness of any dismissal. The cause of the incapacity may also be relevant. In the case of certain kinds of incapacity, for example alcoholism or drug abuse, counselling and rehabilitation may be appropriate steps for an employer to consider.*

Chapter II Section 6 – Prohibition of unfair discrimination, of the EEA states as follows:

- 1) No person may unfairly discriminate, directly or indirectly, against an employee in any employment policy or practice, on one or more grounds, including race, gender, sex, pregnancy, marital status, family responsibility, ethnic or social origin, colour, sexual orientation, age, disability, religion, HIV status, conscience, belief, political opinion, culture, language, birth or on any other arbitrary ground.*

Chapter II Section 7 – Medical testing, of the EEA states as follows:

- 1) Medical testing of an employee is prohibited, unless
 - a. Legislation permits or requires the testing: or*
 - b. It is justifiable in the light of medical facts, employment conditions, social policy, the fair distribution of employee benefits or the inherent requirements of a job.**

Since the decriminalisation of cannabis in South Africa, several labour related cases have been heard in courts that have tested the practicality of this law in the workplace. These cases have argued the principle of fairness in the EEA and LRA as basis for their disputes. One example of a labour matter relating to cannabis use in the workplace was a case between Bernadette Enever and Barloworld Equipment which was recently

heard in a Johannesburg labour court in July 2022 (Enever v Barloworld Case No. JS 633/20 and JS926/20). In this case, the employee had been dismissed after repeatedly testing positive for cannabis and took the employer to court for unfair dismissal arguing that she was using cannabis for medical reasons in her own private place and not in the workplace.

The labour court upheld the dismissal as the employee failed to prove that she had been discriminated against in terms of the provisions of the EEA and the LRA. It was argued that the employer had a strict alcohol and substance abuse policy in place of which the employee was aware of but failed several consecutive urine tests because of the presence of cannabis in her system. Secondly, the employee had failed to disclose to the employer that she had been taking cannabis for medical reasons and did not indicate that she was willing to stop using the substance. The employer was well within their right to dismiss the employee under these circumstances, especially on the basis that the employee was aware of the company policy and had agreed to its terms, including the implications of non-compliance.

The second example of a cannabis related case was recently heard by the Commission for Conciliation, Mediation and Arbitration (CCMA) between Mthembu & others v NCT Durban Wood Chips (Mthembu & others v NCT Durban Wood Chips [2019] 4 BALR 369). In this case, several employees challenged the fairness of the dismissals and took the case to the CCMA seeking relief for dismissal of being under the influence of an intoxicating substance after testing positive for cannabis during working hours, claiming that they had not smoked the drug during working hours, but had consumed it at home in their private time and space.

The Durban Wood Chips is a factory with a zero-tolerance approach to working under the influence of alcohol or drugs due to the highly dangerous and flammable nature of the operations within the factory. The employees were fully aware of this zero-tolerance policy as well as the implications for non-compliance. The CCMA found the dismissals to have been reasonable arguing that although the ConCourt had just declared the private use of cannabis legal, employers were still entitled to enforce safety in their operations by disciplining employees who had tested positive for cannabis use during working hours, regardless of whether it was consumed in private or not. The dismissal

was therefore upheld declaring that the employer had applied the reasonableness and fairness prescribed in the LRA and EEA.

The two labour related cases discussed above clearly show that the decriminalisation of cannabis has zero bearing on the existing legislation as far as OHS is concerned in the SAMI and the rest of South Africa. Employers are empowered to invoke the relevant provisions of the OHSA, GSR, MHSA, LRA and EEA where necessary to maintain and uphold the required standards of OHS in the workplace. It doesn't matter where, when, and how cannabis is consumed as long as the substance is not detected as positive in the body of employees during random or scheduled drug tests that are conducted during working hours. Positive tests may indicate incapacitation and might be deemed unfit to perform their intended duties, thereby invoking applicable legislation that supports potential disciplinary action or dismissal.

Cannabis legislation in the rest of Africa

Cannabis is known to be one of the oldest crops in Africa and has continued to be well cultivated along with other plants that flourish under favorable climate conditions such as ample rainfall, sunlight, elevated temperature, and humidity levels that are unique to Africa (Junior, Gana, Adukeye, & Ahuchaogu, 2023). Amongst others, cannabis, cocoa, and opium poppy are some of the crops which were subjected to international control under certain multilateral treaties in the 20th century (Duvall, 2019). The International Opium Convention which introduced control systems on opium related drugs was institutionalized in 1925 and later revised to replace the existing multilateral treaties for control of narcotic drugs in 1961 (Carrier & Klantschnig, 2020). It was during that period that the post-colonial African states then adopted the prohibitive framework of narcotic drugs to control and restrict cannabis production, possession, and consumption (Rusinga, Klantschnig, Carrier, & Howell, 2022).

Since then, African countries have criminalized cannabis in all aspects of society with harsh penalties for non-compliance. By imposing such legislation, the African governments may have succeeded in lessening the production of cannabis and limiting its use but failed to eradicate the crop itself completely (Charitos et al., 2021). Despite the restrictions, cannabis has continued to be cultivated, distributed, and consumed albeit illegally in all African countries (Rusinga et al., (2022). This illicit

market has continued to pose enormous challenges for law enforcement efforts and control measures in African governments. This and many other factors such as human rights, economic pressure and evolution in science have forced some African countries to review their positions about the legislation on cannabis.

Other than South Africa which is the only African country to have legalized the use of cannabis for recreational purposes, several other African countries have legalized cannabis mainly for the commercial value of export, medical and industry use over the last 7 years as listed below starting with the most recent outcomes:

1. **Ghana** legalized cannabis in 2023 for cultivation and production of cannabis for medical use and industrial purposes (McEvoy, 2023).
2. **Uganda** legalized cannabis in 2023 for licensed cultivation and production for medical use only (Junior et al., 2023).
3. **Mauritius** legalized cannabis in 2023 for medical use only (Junior et al., 2023).
4. **Rwanda** legalized cannabis in 2021 for industrial cultivation and production for medical use only (Anywar et al., 2022).
5. **Morocco** legalised cannabis in 2021 for medical use, cosmetics, and industry purposes (Dalli et al., 2023).
6. **Seychelles** legalised cannabis in 2020 only for medical use (Junior et al., 2023).
7. **Malawi** legalised cannabis in 2020 for commercial cultivation and production for industrial, medical, and scientific use only (Anywar et al., 2022).
8. **Zambia** legalised cannabis in 2019 for licensed cultivation and production to export and for medical use only (Kitchen et al., 2022).
9. **Congo (Brazzaville)** legalised cannabis in 2019 for industrial, medical, and pharmaceutical purposes (Junior et al., 2023).
10. **Zimbabwe** legalised cannabis in 2018 for licensed cultivation and production for industrial and medical use (Muparadzi & Mashau, 2023).
11. **Lesotho** legalised cannabis in 2017 for licensed cultivation and production for medical use only (Anywar et al., 2022).

Implication of Cannabis legislation on OHS in the rest of Africa.

Since cannabis has only been legalized for commercial, industrial, and medical purposes in the rest of Africa and not for recreational purposes like in South Africa, the

issue of OHS in the workplace is a non-topic. Possession and/or use of cannabis is illegal, regardless of where when and how it is done, thereby deeming it illegal in the workplace. If found to be in possession or having used cannabis in the workplace, not only will the employees be disciplined and dismissed, but be subjected to the criminal offences related to cannabis restrictions as stipulated in relevant jurisdictions.

As a result, there is limited literature on the impact of cannabis on OHS for African countries other than South Africa.

Cannabis legislation in the rest of the world

Although the presence of cannabis in the rest of the world is documented as far back as the 2800 BC, the earliest record of its legislation was in the 1300s when an emir of the Joneima in Arabia banned the use of cannabis (Johnson & Ait-Daud, 2011). Since then, other kings and queens banned cannabis in the 1700s and 1800s in countries such as Britain and its colonies, Egypt, Brazil, Greece, and Singapore (Abel 2013), just to name a few.

The banning of cannabis continued in the 1900s across the world with the colonial masters imposing the restrictions onto their colonies in Africa and South America (Carrier & Klantschnig, 2020). Throughout the timelines, the main reason for banning cannabis was to curb the adverse effects thereof on physical, mental health and the interference with social and occupational functioning (Carrier & Klantschnig, 2020). Although cannabis had been used as an indigenous therapy for a variety of medical ailments traditionally, the adverse effects of smoking it far outweighed its benefits (Svrakic et al., 2012).

Towards the late 1900, California in the United States of America (USA) became the first jurisdiction to legalize cannabis for medicine use in 1996 by introducing the Compassionate Use Act of 1996 (Abel 2013). This development set out a global response to decriminalise the cultivation, production, and use of cannabis for industrial and medical purposes throughout the 20th and 21st centuries globally (Abel 2013).

As the scope of legislation continued to grow, several states in the USA such as Washington and Colorado in North America extended the utilisation of cannabis for recreational use in 2014 (Kim & Monte, 2016) and Canada in 2018 (Hammond et al., 2020). In most countries within the Caribbean and South America, cannabis for

personal use is legal as part of the Rastafarian religious practices (Dominguez, 2021). Even in jurisdictions where cannabis is legalised for recreational use, there is still a legal limit of how much one can cultivate or plant. For example, up to 57 grams is allowed in Jamaica, 28 grams in Barbados, 22 grams in Colombia and 8 grams in Peru (Dominguez, 2021). Cannabis is also legalised for recreational use in European countries such as Germany, Spain, and Italy, in Australia, Central America, Asia and the Middle East (Hammond et al., 2020).

Implication of Cannabis legislation on OHS globally.

Similar to OHS concerns experienced in South Africa around the decriminalisation of cannabis for recreational use, all other countries with similar legislation globally are concerned about its implication on OHS in the workplace. A few examples are discussed below.

Canada

In an article by Wolch et al., (2018), the concern pertaining to the decriminalisation of recreational cannabis use without the associated legal guidance on the potential risks to workplace safety in mining in Canada was explicated. It was noted that the decriminalisation of cannabis had no impact on the existing provisions of health and safety in the workplace. The authors further clarified that addressing the OHS risk posed by cannabis should be integrated in the overall safety program guided by the Occupational Health and Safety Act R.R.O. (1996, Reg 854), Mining and Mining Plants and the Canada Criminal Code (R.S.C., 1985, c. C-46).

The Occupational Health and Safety Act R.R.O. (1996, Reg 854), Mining and Mining Plants states as follows:

5. (1) No person under the influence of, or carrying, intoxicating liquor, shall enter or knowingly be permitted to enter a mine or mining plant.

5. (2) Subject to subsection (3), no person under the influence of, or carrying, a drug or narcotic substance shall enter or knowingly be permitted to enter a mine or mining plant.

5. (3) A person required to use a prescription drug and able to perform his or her work may enter a mine or mining plant upon establishing medical proof thereof.

The Canada Criminal Code (R.S.C., 1985, c. C-46) and the renders the responsibility of safety on the employer as follows:

217.1 Everyone who undertakes, or has the authority, to direct how another person does work or performs a task is under a legal duty to take reasonable steps to prevent bodily harm to that person, or any other person, arising from that work or task.

Like the labour cases that challenged the application of the recreational use of cannabis in the workplace as experienced in South Africa, an arbitrator recently heard a matter in which an employee at the Ontario gold mine was suspended and later dismissed after testing positive for cannabis for the second time arguing the basis of personal rights to engage in off-duty recreational cannabis use (Smith, 2023).

In this case, the company had a clear testing policy to be conducted after any serious or high potential incident as well as if a preliminary investigation suggested alcohol or drug use. According to the company policy, employees who tested positive were allowed to continue their employment on condition that they passed a second test before returning to work. The employee was aware of this policy and yet failed the second test after he had failed the first test having been involved in a lube truck incident while at work. Therefore, the arbitrator upheld the termination of employment and dismissed all the grievances brought forward by the employee.

USA

As is the case with legal cannabis for recreational use, but without clear guidance on its management and impact on OHS in Canada and South Africa, the federal laws in the USA are also vague regarding the regulation of cannabis use in the workplace. The regulation of cannabis is included under the general provisions for narcotics in the workplace, as outlined by the Mine Safety and Health Administration (MSHA) and the Occupational Safety and Health Administration OHS Act of 1970 (OSHA). Both the MSHA and OSHA are resolute about the provision that substances that are classified as hazardous or illegal under the federal laws, including narcotics, are prohibited in the workplace.

In response to the inherent dangers present in the mining environment, the labour agency of the MHSA with the help of information solicited from the public reviewed

the regulatory and non-regulatory approaches to deal with the safety risks and hazards due to the impairment of miners because of having used alcohol and other drugs. Section 56.20001 (Intoxicating beverages and narcotics) of the MSHA regulations for metal and non-metal mines was revised as follows:

“Intoxicating beverages and narcotics shall not be permitted or used in or around mines. Persons under the influence of alcohol or narcotics shall not be permitted on the job.”

Section 5 of the OSHA stipulates the duties and responsibilities of employers and employee towards OHS in the workplace as follows:

1. *Each employer*
 - (c) *shall furnish to each of his employees, employment and a place of employment which are free from recognized hazards that are causing or are likely to cause death or serious physical harm to his employees.*
 - (d) *shall comply with occupational safety and health standards promulgated under this Act.*
2. *Each employee shall comply with occupational safety and health standards and all rules, regulations, and orders issued pursuant to this Act which are applicable to his own actions and conduct.*

Similar to the case of Canada and South Africa, the laws around cannabis do not supersede the OHS policies and obligations for individual employers. Commenting on the implications of the use of marijuana in the mining workplace, Deakins (2015) illustrated that the state of Colorado was reluctant to interfere with the discretionary policies implemented by companies. Employers are allowed to apply their own drug policies and testing procedures regardless of where, when, and how marijuana is used stating the following (Deakins, 2015):

- a) *State laws do not require employers to allow marijuana use or permit persons to possess marijuana or be under its influence in the workplace.*
- b) *Marijuana remains illegal under federal law.*

In the context of the USA, the application of the supremacy of the federal law regarding the use of marijuana in the workplace was heard in an employment matter

between *Coats v. Dish Network* (*Coats v. Dish Network, LLC*, 350 P. 3d 849 (Colo. 2015)). In this case, the employee invoked the Colorado statute that protects employees from any negative response by employers because of the former having engaged in unlawful activities off the premises of the later outside of working hours. The employee argued that he had used marijuana while off-duty and away from the employers' premises of business as the law did not prohibit him from using the drug for medical purposes and there was no evidence suggesting that his performance had been affected or impaired while at work.

The verdict was that the federal court of Colorado upheld the ruling of the state court of Colorado for the employer to discipline the employee as marijuana remained unlawful under federal law which supersedes the state laws. Under the federal laws, an employee cannot rely on the lawful off-duty conduct as a basis for violating the employer's zero-tolerance drug policy. Employers are empowered to establish and enforce strict policies aimed at preventing unsafe behaviors that could pose risks or cause harm in the workplace.

3.2.1.3 Different uses of cannabis

As indicated in the previous sections, *Cannabis sativa* is an old plant on earth which has become synonymous with the most versatile taxonomy related to the wide spectrum of its uses. Traditionally, cannabis was used for various applications including medicinal purposes, to produce fiber, ropes, textile, paper and used in the preparation of food mainly during different rituals (Balant, Gras, Ruz, Valles, Vitales & Garnatjie 2021).

The traditional uses of cannabis have since evolved through the millennia because of cultures, innovations and experiences which were passed down from generation to generation and infused into subsequent practices and ways of life. Other than its use for medical purposes, cannabis is popular for its psychoactive component which is used for recreational purposes (Carrier & Klantschnig, 2020). Due to its psychoactive properties, there is enormous demand for research to determine the full impact on OHS in the workplace for those jurisdictions that have legalised its use for recreational purposes.

In a systematic analysis of the CANNUSE database about the traditional uses of cannabis, Balant et al., (2021) placed the use of cannabis into five categories namely medicinal, alimentary, psychoactive, fibre and other. They further analysed the demand of research by these categories and what parts of the cannabis plants are predominantly used for each category as shown in Table 3 below.

Table 3 Cannabis use categories

	Medicinal	Psychoactive	Alimentary	Fibre & Other Use
Research interest	75.41%	8.35%	7.29%	8.95%
Plant parts	Leaf	Inflorescence	Seed	Mixed parts

Source: Adopted from Balant et al., (2021)

As is represented in Table 3, the most researched category is the use of cannabis for medicinal purposes which has been corroborated by many researchers such as Kienzl et al., (2020), Knapp et al., (2019) and Steinmetz, (2017). The high interest in cannabis use for medicinal purposes suggests the potential multidimensional value that this could add to the cannabis ecosystem through academic research. The rigorous research in this area has been instrumental in the decriminalisation of cannabis for medicinal uses globally to foster safe manufacture, production, dispensing and use.

The use of cannabis for fibre, alimentary and other uses have all been researched secondarily with the psychoactive use slowly gaining the most popularity amongst scholars in recent times (Bastien et al., 2023; Graziano et al., 2023; Saleska et al, 2024). Table 3 further shows that the leaves of the cannabis plant are mostly utilised in medicines, with seeds being utilised in alimentary, inflorescence in psychoactive drugs and a mixture of the rest of the plant parts are used in fibre and other products.

Medical cannabis

As indicated above, there is existing literature on the therapeutic use of cannabis for medicinal purposes; some popular reports are discussed below.

Chronic pain management

One of the most reported outcomes on the uses of medical cannabis in literature is the management of chronic pain especially in cancer management, neuropathy and inflammation induced pain (Bicket et al., 2023; Maccarrone et al., 2023; Hill et al., 2023).

The science behind this is that the body consists of peripheral nerves that detect pain sensations (Bicket et al., 2023). Under pain management with cannabis, the Cannabinoid Receptor (CBR) types 1 and 2 have been proven to block the peripheral nerve pains in humans (Bicket et al., 2023), thereby reducing or eliminating the pain.

Severe nausea and vomiting

Cannabis is also associated with the management of nausea and vomiting mainly induced by chemotherapy (Alshaarawy, Balasubramanian, & Venkatesa, 2023; Elgohary et al., 2023). This is made possible by the type 1 CBR which inhibits transient lower oesophageal sphincter relaxation thereby reducing the urge for gastric emptying (Alshaarawy et al., 2023).

Epilepsy management

The management of epilepsy using cannabis is an old form of treatment which has now been scientifically enhanced to remedy treatment-resistant epilepsy as reported by several scientists such as Erridge et al., 2023; Appendino et al., 2019; Suraev et al., 2017). A molecule named lysophosphatidylinositol (LPI) found in the neurons of the brain which amplifies nerve signals passed around the body can sometimes get infected thereby increasing the risk of seizures (Erridge et al., 2023). In this regard, CBD is known to block the infected signals carried by LPI (Erridge et al., 2023) resulting in the reduction of the occurrence or recurrency of seizures.

Depression and anxiety management

Scholars have reported challenges faced when cannabis is used to manage mental health disorders such as depression and anxiety. In the case of anxiety, pure THC seems to decrease anxiety at lower doses and increase it at higher doses while studies that have tested CBD suggest that it appears to decrease anxiety at all doses (Bapir et al., 2023). It is left to chance to administer the correct dosage hoping that the body can respond as expected, which is usually not advisable without scientifically proven doses. In the case of depression, research has suggested that cannabis seems to alleviate feelings of depression in the short-term but also presents potentially enormous risk of harm in the long-term particularly where disorders of abuse of other substances is persistent (Yana et al., 2023). Although used in depression management, the long-term effects could potentially cause more harm than good.

Sleep disorder management

Medical cannabis is increasingly becoming popular as therapy for sleep disorders. Since the decriminalisation of medical cannabis in 2016 in Australia, a couple of recent consumer surveys have been conducted to gauge what medical conditions were being treated by cannabis, whether prescribed or illicitly obtained in the market. These studies found that sleep disorders ranked third after pain and mental health management (Lintzeris et al., 2020; Lintzeris et al., 2022). In the case of medical cannabis for managing sleep disorders, it has been associated with reduced sleep onset latency as well as increased ease of falling asleep, slow-wave sleep and total deep sleep are achieved when THC works on the type 1 CBR in the central nervous system for relaxation (Suraev et al., 2023; Bachhuber et al., 2019).

Psychoactive effects

Other than its use for health benefits, cannabis is also used for its ability to modify the functioning of the nervous system which results in altered behaviour, mood, cognitive ability, and general perceptions of life (Hall et al., 2019). This is what is generally referred to as the recreational use of cannabis which according to Goodman et al., (2020) is the high feeling that is caused by THC, the psychoactive compound found in cannabis and may be responsible for feelings of relaxation, sleepiness, and happiness.

Lancaster (2021) commented on the results of a national survey on marijuana use that had been conducted during the 2017-2019 behavioural risk factor surveillance system in the USA. The commentary summarized the reasons for the use of recreational cannabis amongst teens, adults and long-term users as listed in Table 4 below.

Table 4 Recreational cannabis

Teens	Adults	Long-term users
Fun & enjoyment	Acceptance by peers	Relaxation
Conformity to peer pressure	Emotions and moods management	Forgetting ones worries
Curiosity and experimentation	Sex-related usage	Better sleep
Social motives such as bonding	Social facilitations	Coping with boredom
Coping with boredom		Coping with depression & anxiety
Stress relief		Feeling good & inspiration
		Enjoyment of music or movies
		New ways of looking at things

Source: Adopted from Lancaster (2021)

As evidenced in Table 4, recreational cannabis in teens seems to be used for conformity to peer pressure, curiosity, experimentation, fun and enjoyment. In adults, recreational cannabis seems to be used to manage emotion and mood swings and sex-related usage usually to lower inhibitions. For long-term users, recreational cannabis seems to be used to sleep better, relax, forget ones worries, feel good, as an inspiration to look at things differently and to cope with depression and anxiety. The common recreational uses across all three categories seems to be social motives to bond with others or be accepted by peers and to cope with boredom.

Alimentary

As indicated in the earlier chapters, one of the traditional uses of cannabis was that it was added to homemade foods or commercially manufactured for utilisation during ritual celebrations of certain cultures mainly in Asia and South America. Due to its nutritious nature, all parts of the plant, including the leaves, stem, seeds, roots, and flowers have been used for food, feed, and therapeutic purposes for centuries (Iftikhar et al., 2021).

Complimentary to the traditional alimentary value, scientists have recently confirmed that cannabis can be used to nourish the body through compounds such as CBD and Cannabichromene (CBC) which do not have the psychoactive component like in THC (Cerino et al., 2023). These compounds are being developed to form part of the key ingredients in numerous food items including bakery, confectionery, beverages, dairy, fruits, meat, and vegetables. As shown in Table 3 earlier, alimentary cannabis is mainly extracted from the cannabis seeds which are high in readily digestible proteins, lipids, Polyunsaturated Fatty Acids (PUFA), insoluble fibre, carbs, and favorable omega-6 PUFA acid to omega-3 PUFA ratio and have high nutritional value which provides the antioxidation that nourishes the body (Farinon et al., 2020; Dawadi et al., 2022; Cerino et al., 2023).

Both CBD and CBC come in many forms including oils, liquid extracts, capsules, patches, vapes, sublingual sprays and skin products (Maccarrone et al., 2023). This product is consumed through ingestion (capsules, oils, beverages, vapes, food) or applied externally (lotion, bath oils, patches) (Cerino et al., 2023).

Fibre and Other Use

Scientists have confirmed that one of the major uses of the cannabis plant is the extraction of fibre which is used to make fibre related materials including ropes, threads, filaments, yarns, and all sorts of other fabric (Jasti & Biswas, 2023; Malabadi et al., 2023; Raja, 2023; Karche, 2019). For millennia, the cannabis sativa plant has been recognized as a source of extraordinarily durable fibre which is extracted from the stalks of the plant consisting of two layers (Johnson & Ait-Daud, 2011). The outer layer is formed from rope-like bast fibers used for texture purposes while the inner layer consists of a woody pith which is commonly used for fuel, bamboo, building materials, and animal bedding (Abel, 2013).

It was pointed out in the earlier sections of this document that cannabis is known to have been first documented in the 2800 BC in Asian countries. It is no surprise then that the first known creation of textile from cannabis was in Asia and the Middle East with China being recorded as the biggest net exporter of cannabis related fabric (Johnson & Ait-Daud, 2011). Literature shows that strong fibre material was traditionally the premier choice for rigging and sails on maritime vessels especially as rope material (Abel, 2013). Furthermore, fibre from cannabis sativa was renowned for clothing with cotton and synthetic textures that surpassed any other fabric (Abel, 2013). Although the cannabis plant possesses bast fibre characteristics that are beneficial to humankind, the psychotic element of the plant has overshadowed its benefits due to abuse thereby resulting in restrictive legislation limiting its production, manufacture, and utilisation for its full potential globally.

Recent literature continues to affirm the benefits of the cannabis sativa plant to produce fibre that can be used as fabric for t-shirts, dresses, hoodies, underwear, socks, other forms of apparel, and household textiles in domestic consumption (Jasti & Biswas, 2023; Malabadi et al., 2023; Raja, 2023; Karche, 2019). For industrial consumption, cannabis fibre and wood can be used for ropes, grain bags, wagon covers and construction material, amongst other uses (Saravanakumar, et al., 2021).

Due to its eco-friendly and biodegradable characteristics, the cannabis plant is increasingly becoming popular as a source of renewable energy and contributing towards a green economy (Raja, 2023; Karche, 2019).

Cannabis use in the workplace

In the context of cannabis use in the workplace, it was found that cannabis is commonly used for stamina in physically demanding jobs and as an energy booster (Pelders & Nelson, 2019). A cross-sectional study on cannabis uses in relation to injuries and illnesses in the workplace revealed that cannabis is often used for pain management of injuries and illnesses that are either work-related or non-work related Carnide et al., 2023).

3.2.1.4 Duration of the effects of cannabis on people's systems

In this section, the duration of the effects of cannabis on people's systems is discussed in the context of the psychoactive effects of its use for recreational and medical purposes as it has a direct impact on impairment and workplace safety.

It was pointed out earlier that the component of the cannabis plant responsible for the psychoactive effects in humans' body is THC delta 9 which alters the functioning of the nervous system resulting in altered behaviour, cognition, mood, and perception in humans (Kornpointner et al., 2021). THC contains by-products or metabolites which are fat-soluble or highly lipid-soluble, implying that they bind to or are easily assimilated by fatty tissues and molecules in the body making it longer than usual, for them to metabolize and leave the body (Kornpointner et al., 2021).

Scholars have discussed the metabolisation of cannabis in the body in terms of its half-life which relates to how long it takes the body to metabolize half of the amount of cannabis ingested. Table 5 below shows what different scholars deem to be the minimum half-life of cannabis based on different ingestion methods, quantities, and frequencies as well as the longevity of use. The minimum median half-life is presented at 43 hours (1.8 days), the lowest at 20 hours (0.8 days) and the highest at 84 hours (3.5 days). The maximum half-life of cannabis can range from quadruple the amounts indicated in Table 5 up to 30 days and the full life of up to 90 days or more for frequent users.

Table 5 Half-life of cannabis

#	Source	Study Type	Min Half-Life
1	Peng & Shahidi, 2021	A review of cannabis edibles	20 h (0.8 days)
2	Mørland & Bramness, 2020	A Forensics predictive study of cannabis samples	21.5 h (0.9 days)
3	Millar et al., 2018	A systematic review of pharmacokinetics of cannabis	31 h (1.3 days)
4	Foster, Abramovici & Harris, 2019	A Kinetics Biochemical study of cannabis	35 h (1.5 days)
5	Lucas, Galettis, & Schneider, 2018	A Pharmacodynamics review of cannabis	36 h (1.5 days)
6	Ashley et al., 2020	A Randomized study of administration routes	48 h (2 days)
7	Schep et al., 2020	A toxicology clinical trial	48 h (2 days)
8	Chayasirisobhon, 2020	A Clinical study on chemical reaction	48 h (2 days)
9	Wang et al., 2020	A Prospective observational study	56 h (2.3 days)
10	Sempio et al., 2020	A Pharmacokinetics study	84 h (3.5 days)

According to Ashley et al., (2020), the half-life of cannabis depends on the following:

- a) Method of consumption such as smoking, edibles and sublingual.
- b) Ingesting other substances simultaneously such as alcohol.
- c) Methods used to detect the half-life of cannabis and the time lapse since the last use.
- d) The quality or type of the cannabis strain, quantities, and frequency of use.
- e) A person's individual characteristics such as metabolism and tolerance.

Method of consumption

Cannabis can be ingested through smoking, sniffing, vaping, edibles, and sublingual (Cerino et al., 2023). Cannabis ingested through smoking, vaping or inhalation is quickly absorbed in the bloodstream which activates the metabolites quicker than other methods thereby lessening the half-life significantly in comparison (Ashley et al., 2020). Conversely, cannabis ingested through edibles such as food, drinks, and sublingual releases slowly in the stomach, intestines, and cells before entering the bloodstream thereby increasing the half-life of cannabis (Ashley et al., 2020). The implication in the workplace is that a negative test may not necessarily mean that a person did not consume cannabis as they could have taken it as an edible which would only manifest in the test results much later.

Ingesting other substances simultaneously

Combining cannabis with any other substance that has a similar psychoactive effect on the body accentuates its effect on the body. A typical example of such a substance is alcohol which when used alongside cannabis causes the THC to linger in the body much longer than usual because alcohol contains compounds that slow down the metabolic processes of the body (Chayasirisobhon, 2020). Other prescription medicines have the same effect as alcohol when taken simultaneously with cannabis.

Detection methods

The body of knowledge shows several methods that can be used to detect cannabis in the body as follows:

- i. **Urine** – Cannabis can be detected in urine tests up to 3 days for single use (one joint), up to 7 days for moderate use (four times per week), up to 15 days for chronic use (daily) and up to more than 30 days for chronic heavy use (multiple times per day) (Mørland & Bramness, 2020).
- ii. **Blood** – Cannabis can be detected in the blood sample from within a couple of hours of use for up to 30 days and more for heavy and chronic heavy use (Mørland & Bramness, 2020).
- iii. **Saliva** – Although cannabis can enter the saliva through exposure to second-hand cannabis smoke, its metabolites are only present in the saliva when personally ingested or inhaled and is detectable within a few minutes of use, lasting up to 3 days (Karschner et al., 2020).
- iv. **Hair** – Follicles of hair taken within 1.5 inch of the scalp can provide a timeline of cannabis use over the past 90 days (Mørland & Bramness, 2020).

The implication of this is that the saliva test method will not show that someone consumed cannabis beyond the 3 days window that it is able to detect due to the long half-life of cannabis and the hair test method will not detect cannabis on a person who just consumed cannabis in the last 30 minutes. Therefore, selecting an appropriate method depends on the desired detection period and accuracy in reflecting cannabis presence in an individual's system.

The quality, dose, and frequency of use

The quality of cannabis, dose and frequency of use have a significant impact on the half-life of cannabis and its detection timelines. The quality of cannabis mainly relates

to the concentration of THC and CBD with the former being more potent than the latter based on the type of plant, whether male or female and whether the plant contains seeds or not (Goodman et al., 2020). It goes without saying that the higher the quality of cannabis and the larger the doses taken and the more frequent the use, the higher the tolerance to cannabis and the higher the detection timelines and half-life (Bastien et al., 2023; Graziano et al., 2023; Saleska et al., 2024). This is because it would take longer for the high-quality cannabis to metabolize compared to lower-quality cannabis.

Similarly, taking high doses within a short period of time would take longer to metabolize from the system as the body has a ceiling on the amount it can metabolize molecules for a given period. In addition, the more frequently cannabis is ingested the more resistant the tolerance becomes resulting in increased dosage and usage to achieve the same level of high.

Individual characteristics

The individual characteristics of a person play a large part in how long it takes for cannabis metabolites to stay in the system. An individual's Body Mass Index (BMI) and metabolic rate influence how the body breaks down and processes substances (Lin et al., 2023). A lower BMI is associated with a higher metabolic rate which in turn reduces the time it takes for cannabis to metabolize out of the body (Lin et al., 2023). This is because persons with low BMI have less fat in their cells such that less cannabis molecules can bind in the body. Conversely, persons with high BMI will metabolize cannabis longer due to the large deposits in their body fats.

3.2.1.5 Definition of intoxication and being under the influence of cannabis

The Cambridge Dictionary (Word of year 2023) describes intoxication as a noun which refers to a condition of having lost some control of one's actions or behaviour under the influence of a drug. As an adjective, 'intoxicated' describes a state of being where one is affected to the point that one's physical and mental control are diminished tremendously. From another perspective of an adjective, 'intoxicating' makes one feel a strong sense of excitement or happiness. "Under the influence" is an idiom which expresses intoxicated in other words and is described as the degree of impairment of the mental faculties of an individual to the extent that they cannot safely perform a given activity because they are affected or controlled by the intoxicating substance.

There is extant literature on intoxication as it relates to the education system particularly in adolescents (Cai et al., 2021; Rossow, Pape & Torgersen, 2020; Pape & Rossow, 2021), road safety (Garrisson et al., 2021; Patrick et al., 2021; Motschman et al., 2020) and workplace (Stumbrys & Tamutienė, 2021; Borrelli et al., 2022; Hazle, Hill & Westreich, 2022). In terms of intoxication and being under the influence of cannabis or any other drugs in the workplace, it is the responsibility of employers to prove that an employee is guilty because testing positive for an intoxicating substance doesn't necessarily mean that they are under its influence. This is because of the chemical structure of cannabis and its slow release and metabolism throughout its half and full life. Although the intoxication can reach its maximum effects during the first few hours of ingestion in the body, sobriety is achieved soon thereafter and although the traces of cannabis are detectable for much longer periods as indicated earlier in the document, the person may not necessarily be under its influence anymore.

Several scholars have shown that an employee who is intoxicated may be seen by appearing dizzy, impaired coordination and psychomotor skills, lack of defensive reflexes, aggressive behaviour, stumbling, slurred speech and bloodshot eyes (Toney-Butler & Siela, 2018; Nikathil et al., 2017; Bhattacharya, 2019; Stumbrys & Tamutienė, 2021). To prove under the influence, the employer merely needs to show that the employee was incapable of performing their duties, even without expert observation, according to Toney-Butler & Siela, (2018).

There are several cases where intoxication needed to be proven in arbitration to support or deny the application brought forward. A few are discussed below.

1. ***Tosca Labs v CCMA 2012 33 ILJ 1738 (LC)*** – in this case, the labour court found the dismissal of the employee substantively unfair arguing that a positive test result on a breathalyzer test was not sufficient proof to indicate that the employee was under the influence of alcohol. The employer had failed to prove that the employee's competence to perform their work has been impaired.
2. ***South African Breweries v CCMA and others (C 665/2011) [2012] ZALCCT 17*** – In this case, the employee who was a process operator on the production line had been dismissed summarily after he had opened a bottle of beer and drank some of it on duty. The arbitrator found that although the employee had broken company substance abuse policy, the testing conducted did not show he

was under the influence of alcohol and further that the employee did not cause any harm to the employer. The employee was charged with drinking alcohol on duty, operating machinery after having consumed alcohol in the workplace and unauthorized removal and consumption of SAB products on site.

3. ***Tanker Services (Pty) Ltd v Magudulela 1997 12 BLLR 1552 (LAC)*** – in this case, the court upheld the dismissal of an employee for being under the influence of alcohol while driving a 32-ton articulated vehicle belonging to the employer. The court held that an employee is ‘under the influence of alcohol’ if he is unable to perform the tasks entrusted to him with the skill expected of a sober person. It had been proven to the court that the faculties of the employee had been impaired to the extent that he could no longer perform the skilled technically complex and highly responsible task of driving an extraordinarily heavy vehicle carrying hazardous substances.
4. ***NUMSA obo Motsele vs Haggie Wire and Strand 2006, 2 BALR 163*** - in this case, the arbitrator upheld the dismissal arguing that the employee’s conduct rendered the continuation of the employment relationship intolerable. This was after the arbitrator found that there was sufficient evidence to show that the employee was intoxicated and that even if the employee denied that his condition had impaired the ability to work, he was aware of the potential consequences of his action. The arbitrator further rehashed the fact that the employer is entitled to set standards of conduct which arbitrators should not interfere with.

As is evidenced in the sample cases above, intoxication in the workplace needs to be proven to justify the resultant punitive measures. Over and above, the employer has the right to set out standards of operations within each operation and prescribe rules specific to that area of work. While the zero tolerance of the substance abuse policy is blanketly applied within organisations, some type of work attracts more stringent rules than others due to the level of risk involved. Even when recourse is applied, the nature of risk associated with the area of work is highlighted and applied.

3.2.1.6 Effects of the use of cannabis on people in general

The effects of the use of cannabis on human bodies is generally caused by the chemical compounds in the cannabis plant including over 300 cannabinoids and terpenes (Kornpointner et al., 2021). The products made from chemical compounds in cannabis

have various psychological and physiological or somatic effects on the human body once metabolized (Chayasirisobhon, 2020). The metabolism of cannabis and its effect on the body depends on the mode of consumption. When inhaled, the cannabis chemical compounds enter the bloodstream at a much quicker pace through the lungs and impacts the body faster than when taken orally (Chayasirisobhon, 2020). When consumed orally, the chemical compounds of cannabis travel to the liver at a much slower release pace where it is eliminated through the normal excretion mechanism or metabolized (Chayasirisobhon, 2020). Thus, the effects of cannabis on the human body are studied within an interconnected framework of dynamic elements within its psychological and physiological ecology.

Psychological effects of cannabis

As indicated earlier, the main compound in cannabis with psychoactive properties that can alter the human mind and how it works is THC. Scientists have shown that the THC chemical structure is similar to the brain's fatty acid neurotransmitter called anandamide, which is responsible for modulating the brain reward circuitry (Alonso-Esteban et al., 2022; Kornpointner et al., 2021; Chayasirisobhon, 2020). As such, the similarity allows the brain to recognize cannabinoid receptors as a neurotransmitter sending chemical messages between neurons throughout the central nervous system thereby altering the normal communication in the brain. This may then positively or negatively affect the areas of the brain that influence pleasure, memory, thinking, concentration, movements, coordination, sensory and time perception such as the cerebellum and basal ganglia (Pape & Rossow, 2021).

One prominent reaction of cannabinoid receptors is the activation of the brain's reward system which governs the response to healthy pleasurable behaviors such as eating and sex by using the dopamine chemical which teaches the brain to repeat the rewarding behaviour. This is what accounts for addiction in the case of cannabis as revealed in a systematic review of cannabis addiction and mental illness by Petrollo et al., (2022).

Scientists have shown further psychological effects of cannabis on humans in the short term as affecting the central nervous system by causing a general altered state of consciousness, euphoria, psychosis, anxiety, relaxation, joviality, lower reaction time, increased heart rate and loss of coordination, amongst others (Cai et al., 2021; Rossow,

Pape & Torgersen, 2020; Pape & Rossow, 2021; Garrisson et al., 2021; Patrick et al., 2021; Motschman et al., 2020; Stumbrys & Tamutienė, 2021; Borrelli et al., 2022; Hazle, Hill & Westreich, 2022).

In the long term, the major psychological effects of cannabis on humans are known by scientists to be psychosis, which is a mental disorder in which one experiences loss of contact with reality and may results in schizophrenia described as loss of the ability to think, feel, and behave clearly (Garrisson et al., 2021; Patrick et al., 2021; Motschman et al., 2020). In adolescent and even adults, cannabis use in the long term may cause a declined Intelligence Quotient (IQ), poor performance and violence (Cai et al., 2021; Rossow, Pape & Torgersen, 2020).

Physiological (somatic) effects of cannabis

The physiological or somatic effects of cannabis on the humans' body relate to how the drug impacts the functioning and mechanisms of the body, distinct from its psychological effects. As discussed throughout this document, cannabis has both positive and negative impacts on the human body due to its chemical makeup of numerous compounds. Cannabis for medical, alimentary, and other purposes were discussed in depth in the section on cannabis benefits above.

Scientists have shown that the somatic effects of cannabis on humans in the short term generally include loss of coordination, lower reaction time, increased heart rate, dry mouth, reddened eyes due to high blood circulation causing blood vessels to expand with more blood, muscle relaxation and a sensation of hot and cold hands and feet, amongst others (Garrisson et al., 2021; Patrick et al., 2021; Motschman et al., 2020; Stumbrys & Tamutienė, 2021; Borrelli et al., 2022 Hazle, Hill & Westreich, 2022). The long-term effects of cannabis on the human body are discussed below.

1. **Respiratory system** - cannabis has been shown to decrease pulmonary function, produce chronic cough, inflammation of airways, bronchitis, abnormal growth of cells in the long term which may antecede the onset of carcinogenesis cancer as well as activation of asthma, cystic fibrosis and Chronic Obstructive Pulmonary disease (COPD) (Vozoris et al., 2022; Sack, Simpson & Pacheco, 2023).
2. **Immune system** – While cannabis is known as a solution to treat the side effects of diseases especially as remedy for pain management, it is also known to

contain immunosuppression resulting from isolated active compounds during preparation (Khoury, Cohen & Bar-Sela, 2022). A suppressed immune system is susceptible to infections and opportunistic diseases such as Tuberculosis and Human Immunodeficiency (HIV) (Khoury, Cohen & Bar-Sela, 2022). Some scientists argue that cannabis may benefit patients who have autoimmune conditions with overactive immune systems by reducing the overactivity (Devi et al., 2022).

3. **Digestive system** – Like many effects on the human body, cannabis may have positive and negative effects on the digestive system. It was shown earlier in this document that cannabis can ease nausea and vomiting but may paradoxically cause nausea and vomiting in the long term (Alshaarawy, Balasubramanian, & Venkatesa, 2023). Furthermore, the THC component in cannabis can increase appetite which can benefit people wishing to gain weight or increase appetite like cancer patients receiving chemotherapy (Elgohary et al., 2023). Additionally, scientists have found that cannabis users metabolize and activate or inactivate drugs more slowly than normal which may potentiate the deleterious effects of the drugs in the system, resulting in potential harm to the liver (Kaufmann et al., 2023).
4. **Cardiovascular system** – One of the immediate effects of cannabis ingestion is that it increases the circulation of blood in the body using the existing size of blood vessels potentially rising the blood pressure. In patients with cardiac history, THC is unsafe as the direct stimulation of the cardiac pacemakers are aggravated increasing the change of cardiac arrest (Vozoris et al., 2022; Sack, Simpson & Pacheco, 2023).
5. **Endocrine and Reproductive system** – Secondary to the psychotic effects, cannabis fundamentally affects the endocrine system which is responsible for hormonal regulation of metabolism, reproduction, growth and development and homeostasis in the body (Maccarrone et al., 2021). As an example, cannabis can disrupt the functioning of the reproductive system by reducing gestation in women causing low birth weight of infants (Maccarrone et al., 2021).

3.2.1.7 The Impact of cannabis on workplace safety and productivity

The issue of employers' and employees' responsibility towards workplace safety was addressed extensively earlier in the document when in-country legalisation of cannabis

for recreational use was reviewed. It was shown that employers must provide a safe working environment while employees must also declare anything that could decrease their ability to work safely or to undertake work in a safe manner or threaten the health and safety of themselves and others in the workplace. Furthermore, the importance of a policy stipulating the terms and conditions of substance use and abuse in the workplace to which both employer and employee must adhere was emphasised.

The issue of intoxication and being under the influence was subsequently discussed showing that impairment due to intoxication of cannabis is known to metabolize within 8 hours of ingestion or longer depending on factors such as the quality of drug, method of ingestion, frequency and quantity of dosage, simultaneous intake of other drugs with psychoactive propensities and the method used to test the drug. Thereafter, the psychological and somatic effects of cannabis on the human brain and body respectively, were presented showing the associated impairment and effects of the drug.

When applied to OHS, the effects of cannabis on workplace safety and productivity are none different from the application in any other setting as the fundamental impacts on the psychological and physiological functioning of the body are the same. Commenting on testing for cannabis in the mining industry after legalisation of cannabis for recreational purposes in South Africa, Louw & Johnson (2020) listed the following as the potential negative impacts of cannabis on an employee's occupational capacity:

- Performing tasks slower than usual.
- Performing poorly when handling routine, monotonous tasks.
- Difficulty in multi-tasking.
- Difficulty in taking instructions.
- Difficulty in making crucial decisions especially in high-risk situations.
- Difficulty in operating machinery and or motor vehicles.

Each of the listed outcomes of cannabis consumption have a direct or indirect impact of workplace safety and productivity. For example, loss of neuro coordination would cause slow reaction time to risky tasks like operation of machinery or evading danger and may impact safety and productivity negatively in that manner. Similarly, difficulties in taking instructions or multitasking and even failure to perform routine tasks would result in loss of productivity and potentially compromise safety.

There is extant literature in support of Louw & Johnson's (2020) assertion of the impact of cannabis on employee's capacity, mainly viewed from a medical cannabis perspective rather than from a recreational perspective. In a systematic review of literature published between 2015 and 2021 on the impact of cannabis and its adverse effects on workplace health and safety, O'Neill et al., (2023) found that the most prevalent adverse effects are sedation, dizziness, and euphoria. These adverse effects were found to associate with increased workplace risks including decreased alertness and reaction time, increased absenteeism, reduced ability to safely drive or operate machinery and an increased probability of falling. The participants had used cannabis mainly for medicinal purposes. This systematic review recommended that focused research into the risks of cannabis use in relation to workplace performance impairment be conducted across industries.

Another longitudinal study of Canadian workers was conducted by Carnide et al., (2023) to prove the association of the risk of workplace injury between workplace and non-workplace cannabis users. A cohort of workplace use was those who used cannabis during working hours while the cohort of non-workplace users was those who used cannabis outside of working hours. The findings were that workplace use of cannabis was associated with an almost two-fold increased risk of experiencing a workplace injury compared to non-workplace users. This is consistent with the discussion above on the metabolism rate of cannabis which is said to be at peak within the first 8 hours of consumption, during which the employee may still be at work, facing an increased risk of injury.

Another study by Hinton & Asher (2022) was conducted in the USA to determine the potential for impairment when employees consumed cannabis products with unverified levels of THC. The aim was to test the hypothesis that CBD related products containing up to 0.03% THC posed a high risk of a workplace injury or illness using a sample of 100 respondents from all industries. The results of that study did not provide conclusive evidence to support the null hypothesis due to the skewness of the responses. Yet again, this study recommended more research to understand the true levels of impairment associated with the use and consumption of cannabis with specific levels (percentages) of THC that are allowable in the workplace, above which it would be deemed a risk to workplace safety.

While extant literature is available on the potential effects of cannabis on the human body, more research is needed to associate workplace safety and productivity with cannabis use, particularly now that more jurisdictions have relaxed their cannabis legislation to include recreational use.

3.2.1.8 Testing of cannabis using non-invasive methods.

Testing for the presence of cannabis falls within the general drug testing processes or the science of toxicology aimed at determining the presence or absence of specified parent drugs or their metabolites (Schep et al., 2020). It may also be referred to as testing that provides a quantitative chemical or biological analysis of the illegal substance commonly intended to assist with the responsible use of the drug under analysis (Chayasirisobhon, 2020).

Drug testing has been applied in different scenarios such as in sports, to detect the presence of performance enhancing steroids amongst sports participants (Peng & Shahidi, 2021). It is also applied in employment to screen employees for drugs that are prohibited by law or company policy mainly conducted on pre-employment for certain job types and routinely to maintain safety or in cases of suspected intoxication and for employment exit certification (Van Zyl, 2020). Drug testing is further applied in law enforcement by police on the general driving public to test for the presence and concentration of alcohol in the body commonly referred to as Blood Alcohol Content (BAC) (Fell, 2020).

Drug testing may also be applied for forensics purposes as part of investigation of court cases to provide evidence of criminality or by parole and probation officers to test compliance to the parole or probation conditions (Mørland & Bramness, 2020). Another application of drug testing is for medical purposes to test for scenarios such as assessment of drug use or misuse by patients awaiting an organ transplant or monitoring for prescription and chronic medication usage (Elgohary et al., 2023).

Generally, drug testing is conducted in two categories namely, screening tests and confirmation tests (Petrilli et al., 2022). The screening test is an immunoassay that is conducted to separate patients that are negative from those that are not using simple but sophisticated equipment on-site. The samples that test non-negative with the screening test are then subjected to a confirmation test. The confirmation test will

identify the specific drug present, or if the confirmation test is negative, then the screening test result is classified as a false-positive. Confirmation tests are performed in the laboratory setting using highly specialized instruments and are more expensive than screening test and takes longer to obtain a result.

In cannabis testing, the main target compound that is measured is the presence of THC. As indicated in earlier sections of this document, THC contains by-products or metabolites which are fat-soluble or highly lipid-soluble, implying that they bind to or are easily assimilated by fatty tissues and molecules in the body making it longer than usual, for them to metabolize and leave the body (Kornpointner et al., 2021). There are five primary methods that are typically used to test for the presence of THC globally as discussed below (Mørland & Bramness, 2020; Karschner et al., 2020) and are also available in South Africa (De Greef, 2015).

- 1) **Urine test** – is one of the non-invasive screening tests used to detect the presence of cannabis and is considered less expensive compared to other methods. A specific dipstick containing a panel of markers is placed in the urine causing the chemical strips to change colour, indicating the presence of cannabis. Non-negative results are then referred for confirmation tests mainly using invasive methods such as blood samples.
- 2) **Saliva test** - is the other non-invasive test used to detect the presence of cannabis and is considered less expensive, although a bit more expensive than urine tests as it is usually analysed in a laboratory setting. A saliva sample is generally taken sublingually using a swab and can be applied as a presumptive or confirmatory test.
- 3) **Hair test** – Also a non-invasive screening test method that can be used to detect the presence of cannabis and is considered an expensive mode of testing compared to urine and saliva tests although more effective regardless of the metabolic period. Hair follicles of about the diameter of a pencil are harvested within 1.5 inch of the scalp and analysed in a laboratory setting.
- 4) **Blood test** - is an invasive, most accurate and most expensive confirmatory test used to detect the presence and concentration of cannabis. Blood is drawn from the body in a venipuncture procedure and analysed in a laboratory setting.
- 5) **Sweat test** - is a screening test used to detect the presence of cannabis and is deemed to be semi-invasive since it may require wearing the patch on the body

for an extended period than is comfortable. The patch is worn for approximately 30 minutes to catch the sweat generated from the body and then analysed in a laboratory setting.

Table 6 below captures the approximate detection periods by test type as summarized by Karschner et al., 2020). As with the half-life of cannabis, the detection period is influenced by several factors including metabolic rate, BMI, quality of THC, dosage, frequency, and overall tolerance. Table 6 shows that the presence of cannabis can be detected in the body the longest through hair follicles and the shortest through saliva.

Table 6 Detection period by test type

Frequency and type of use	Saliva	Blood	Sweat	Urine	Hair
Shortest detectability -----> Longest detectability					
Smocked - Single use	12 – 24 hours	1 – 3 days	1 – 10 days	1 – 3 days	0 – 90 days
Smoked - Regular use	12 – 24 hours	1 – 2 weeks	Up to 14 days	15-50 days	0 to 120 days
Oral – Single use	12 – 24 hours	2 – 7 days	1 – 10 days	2 – 10 days	0 – 90 days

Workplace cannabis testing

Since the decriminalisation of cannabis for recreational use in many countries, its possession and use has been on the rise and workplace safety has emerged as a complex and challenging issue for business owners and employees. As discussed earlier, cannabis use has the potential to impair an individual's motor skills, short-term memory, and ability to drive or operate heavy machinery, raising concerns about how best to protect workers, customers, business owners, and everyone in the business ecosystem.

At the same time, advancements in technology for accurately testing workplace impairment have not kept up with the changes in cannabis-related policies. The complexity lies in the inability of traditional drug detection methods to produce correct results and precise measurements of cannabis impairment due to its long half-life resulting in false positives or incorrect identification of individuals who may not actually be impaired despite having consumed cannabis in their private space. Moreover, the matter of workplace impairment and cannabis drug testing in conjunction with recreational or medicinal use is intertwined in the fabric of human rights further compounding the challenges of its management in the workplace.

It is therefore necessary to understand how countries have responded to cannabis testing in the workplace following recent legalisation for recreational use.

South Africa

When the ConCourt of South Africa legalised the cannabis for recreational use, it did not provide guidance on how employers should deal with or manage it in the workplace. Instead, the legislation opted to leave the parameters for its management in the workplace to the employers, allowing them to assess what approach best suits their company (Van Zyl 2020). The underlying policies in the employers' favour include the LRA, the EEA, the OHSA and the MHSA, in the case of mining companies as discussed earlier in this document which empowers employers to set standards that do not compromise safety in the workplace. Since the employment contract is underpinned by a reciprocated relationship where both parties have rights and duties towards each other, it makes sense that each employer stipulates their own rights and duties towards the employee and the latter consents to those prescriptions, both parties knowing the full impact of their relationship (Enslin, 2022).

It is on this legal premise that cannabis testing is carried out in the South African workplace. Each employer is expected to implement policy around the management of cannabis in the workplace and ensure that the employees are fully aware of it at the point of employment. Under this understanding, an employer can continue to legally test employees for cannabis and take adverse employment action against those who test positive during working hours. Additionally, it is left to the employer to define and implement the parameters by which cannabis should be tested in terms of instrument, measurement, implications, and recourse.

At the time of writing this document, the authors did not find any literature showing clear guidelines regarding how impairment testing due to cannabis should be conducted in the workplace in South Africa, nor did they find any bespoke legal limits of cannabis in the body that should suggest impairment and disallowed in the workplace. Other than the general codes of conduct on substance abuse in the workplace specific to individual companies and industries, the authors could only find rulings from court cases and arbitration brought forward as appeals for dismissals due to non-negative test results for cannabis. Even then, the type of insights are retrospective in nature and do not provide a standard by which cannabis should be managed in the workplace proactively.

USA

Similar to the challenge faced in South Africa, the decriminalisation of cannabis for recreational use in the USA has presented a myriad of complexities with varied facets to workplace safety for which the solutions are not readily available (Gruber, Hudak & Sagar, 2023). However, policymakers and business owners in states where cannabis has been legalized for medical and recreational use have continued to look for ways of dealing with the challenges including lobbying ballot drafters and legislators to empower businesses to set their own rules allowing workplace testing for cannabis and use the positive test outcome as legal basis for termination of employment (Gruber et al., 2023).

Per se limits and zero tolerance

With the progression of time, businesses and legislators are beginning to realise that a one-size-fits-all approach for cannabis enforcement in the workplace is largely inappropriate and outdated in most instances. This is because the traditional way of testing for cannabis is being challenged due to invalidity of the test results. In the traditional method, the results of workplace drug tests, including cannabis, are designed to detect recent use of cannabis or cannabinoid-based products, but a positive test does not necessarily reflect impairment. In measuring workplace impairment, the states and private businesses in cannabis legal jurisdictions have implemented the zero tolerance drug testing policies and the “per se” rules (Lechleiter 2024).

Zero tolerance policies, most utilised in workplace drug testing protocols, provide the employer grounds to terminate an employee if the presence of cannabis or its metabolites is present. This policy states that any amount of cannabis or its metabolites in one’s system is considered excessive by the employer regardless of whether the employee is intoxicated or not.

The per se rules, on the other hand, set a standard measure of impairment and thus grounds for termination of employment. In the context of driving under the influence, many states set this per se limit at five nanograms per milliliter of blood or equivalent for testing other biospecimens such as urine (Lacey et al., 2010; Avila, 2011; Walsh, 2009; Norml, 2014). This standard dictates any measurement at that limit or higher to demonstrate impairment. Per se rules are controversial, particularly as they are held up as having the same measurement validity as blood alcohol tests’ designation of impairment and applied to cannabis. This is far from the truth because alcohol

metabolizes quicker from the body compared to cannabis and therefore cannot use the same measure. To compound the problem further, some jurisdictions within the USA do not only limit testing of cannabis to active delta-9-THC but also include active and inactive metabolites, the latter of which demonstrates that an individual has used THC at some point in the recent past, and not necessarily that they are impaired.

Several scientists have proposed the legal per se limit for marijuana to be between two and five nanograms per milliliter of blood (Wong, Brandy & Li, 2019; Pearlson, Stevens & D'Souza, 2021), but another simulated study found that per se limits to detect cannabis induced driving impairment is not reliable due to other confounders that could be present at the time of testing. Be that as it may, the proposed per se limits relate to driving impairment only and none for workplace impairment.

While these policies are commonplace and acceptable in the USA, neither the zero-tolerance rule nor the per se limits accurately measure impairment, and the zero-tolerance policy provides a sloppy approach to workplace safety. Given the duration of time cannabis metabolites remain in one's system, a zero-tolerance policy can punish an individual who lacks any impairment and used cannabis responsibly outside of work hours. In the same breath, a comparison with the alcohol per se limit is Unsuitable because alcohol metabolizes out of the system much sooner than cannabis does. The argument is that employers should not terminate an employee who consumed a cannabis edible over the weekend while treating differently an employee who drank a few glasses of wine during the same period, simply because the former tested positive for cannabis while the latter tested negative for alcohol, due to the differing metabolic processes of the two substances.

Impairment testing

Considering the controversies related to cannabis testing, conversations about how to improve workplace drug testing rules in general USA are becoming widely spread and louder shifting the fundamentals of substance abuse testing in the workplace (Lechleiter 2024). Following the workplace transformation events that transpired during the COVID-19 pandemic, employers in the USA, as with the rest of the world, have started redefining traditional rules about workplace safety to focus on efficiencies, cost saving and better experience for employees. Some employers in cannabis-legal states and even in large transnational corporations have taken very public steps toward eliminating

drug testing policies altogether after having been dragged to courts for issues of equity and justice when reconsidering workplace drug testing policies and the procedures used to enforce such rules (Lechleiter 2024).

Recently, the states of New York, New Jersey, Connecticut, Rhode Island, Washington DC, Illinois, and Montana are currently in the process of modifying the statutes to protect the rights of employees to use recreational cannabis while off-duty through impairment testing rather than the cannabis testing (Lechleiter 2024). The contemplated solution is to adopt a two-step approach starting with impairment testing and then confirmatory testing to establish impairment and verify that a person has cannabis in their system through a THC test (Lechleiter 2024). This approach is envisaged to become more efficient in determining which employees are indeed actually impaired in the workplace and will lower the risk of false allegations resulting in adverse employment actions against employees who are using recreational cannabis during their personal time.

Canada

Currently, there is no specific provision in the Canadian Labour Code (R.S.C., 1985, c L-2), addressing the management of cannabis in the workplace. However, the code in section 122 does require that employers develop and implement programs to prevent hazards to protect employees, which may include policies related to impairment including the use of drugs and alcohol. Additionally, the Cannabis Act (SC 2018, c. 16) includes amendments to the Non-Smokers' Health Act (R.S.C., 1985, c. 15 (4th Supp.)) (NSHA) to prohibit the smoking and vaping of cannabis in workplaces. The purpose of the NSHA is to protect non-smokers from second-hand smoke in federally regulated workplaces.

The general approach for cannabis management in the workplace across Canada is based on how the employer can best implement safety in a manner that accommodates various legal aspects. In deciding whether and how to conduct cannabis testing in the workplace, an employer is required to consider a variety of factors including human rights law, safety, privacy, labour standards, the provisions of any applicable collective agreements, regulatory requirements, the level of supervision available in the workplace, among other considerations (Lam, 2019). It is therefore recommended that employers seek legal advice before implementing a cannabis testing program. Some

guidance may also be available through occupational health and safety and human rights agencies in each jurisdiction (Carnide et al., 2022).

As is the case with South Africa and the USA, employers in Canada are required to have a clearly defined policy that outlines the criteria for testing procedures (Lam, 2019). If testing is to be part of the program, it should be completed in a manner that protects the privacy, dignity, and confidentiality of the employee being tested, and results are only shared with necessary persons (e.g., the employee, the supervisor, or human resources) (Lam, 2019).

Europe, Asia, Australia, Middle East, and South America

In the rest of the world where recreational cannabis is legalised, the guidelines relating to workplace testing for cannabis are scantily documented. Testing for cannabis is treated under the general guidelines for substance testing in the workplace as is prescribed in the legal framework for each country. What seems to be available in the literature is either the reference to cannabis in relation to in-country labour, safety and medical legislation (Condon et al., 2023; Smith et al., 2021; Kulig, 2017) or research efforts to understand the impact of cannabis testing using the existing methods such as urine, saliva, blood and hair (Navazesh & Ahmadi, 2020; Jouanjus et al., 2021; Taskinen et al., 2017).

Similar to the overarching guidelines for cannabis management in the workplace for Canada, USA and South Africa, the responsibility is accorded to the employers in the rest of the world to implement testing policies and procedures for the management of cannabis in conjunction with other in-country health and safety guidelines as well as human rights. Unlike the USA where the impact of recreational cannabis is mature, the rest of the world is still using the traditional methods of substance abuse to test for the presence of cannabis in the workplace, which as discussed earlier, are not accurate.

3.2.1.9 Latest trends in technology for impairment testing

In response to the emerging shift in workplace substance abuse management, which advocates moving from substance abuse testing to impairment testing, scientists have started leveraging the power of technology and Artificial Intelligence (AI) to develop fit for purpose solutions that can test impairment due to cannabis in the workplace. A few examples of technology to identify individuals impaired by THC are discussed below.

- 1) **Functional near infrared spectroscopy (fNIRS)** – is non-invasive technology which uses brain imaging to scan and see when a brain shows signs of impairment (Walia et al., 2022; Zhu et al., 2019; Gilman et al., 2022).
- 2) **Gaize virtual reality (VR) drug recognition expert (DRE) headset** – is non-invasive AI technology that automatically runs the same eye tests as specially trained police DRE using a VR headset. Using embedded eye tracking sensors, it captures over 120,000 datapoints per test, which are then evaluated for signs of impairment (Gaize Inc, 2023; Lechleiter 2024).
- 3) **Druid impairment testing app** – is a non-invasive technology mobile app that assess a persons' level of cognitive and motor impairment for any cause including cannabis (Spindle et al., 2021; Arkell at al., 2023; Impairment Science Inc. 2025).

Conclusions from Milestone 2

The literature reviewed in this milestone covered a wide scope of cannabis topics and revealed a great deal of insights for consideration including cannabis legislation, different uses, effects on the body and its impact on workplace safety and productivity. The general observation from the literature is that legalizing recreational cannabis is a new phenomenon globally whose full impact on workplace productivity and safety is yet to be determined and quantified. The countries which legalised recreational cannabis did not provide guidelines for its management in the workplace and assumed that employers would apply existing alcohol and drugs abuse policies and procedures to manage its impact.

However, the chemical characteristics of cannabis are different from the usual drugs because it takes longer for cannabis to metabolize out of the body. While a test result might be positive using the traditional non-invasive and invasive methods of testing drugs, the cannabis user may not necessarily be under its influence due to its half-life properties thereby presenting a conundrum for employers to manage. The law permits adults or employees to possess and use cannabis in their private spaces and will claim unfair dismissal as a punitive measure for a positive cannabis test result regardless of the status of inability to perform duty. Nevertheless, cannabis remains a drug with psychoactive properties that might pose a risk to workplace productivity and safety if not managed adequately particularly in the SAMI due to the nature of dangerous work.

Although the benefits of cannabis are widely documented, the potential negative impact on employee productivity and general safety in the workplace cannot be understated.

It was determined in the literature that the traditional ways of assessing and testing for the presence of drugs in the workplace are inadequate for cannabis and that there are no alternative guidelines on how testing should be done. It became clear that the SAMI needed to deliberate on cannabis decriminalisation and devise specific strategies to manage it and maintain health, safety and productivity in the workplace while upholding the human right provisions.

3.3 MILESTONE 3

Results and Outcomes per Milestone 3

As mentioned earlier, the aim of milestone 3 was to conduct a survey on the perspectives of the stakeholders in the SAMI about the decriminalisation of cannabis use and the effect on the policies. The results are presented in the following sub-sections:

- A. Presentation and interpretation of the results
- B. Discussion of the results

A. PRESENTATION AND INTERPRETATION OF THE RESULTS

Results obtained from the statistical analysis of the survey are presented and interpreted in this section of the report. The information collected from the survey was used to analyse the opinions of stakeholders in the SAMI about the decriminalisation of cannabis and its impact on safety policies and procedures. Results from descriptive statistics, frequency distributions and triangulated interpretations are also presented in this section.

The target sample for this survey study was a minimum of 194 participants (N=194), determined based on the ToR for this research project. However, the actual total number of participants was two hundred and nine (N=209) as shown in **Table 7** below.

Table 7 Planned vs actual sample representation

#	Sample Representation	Planned	Actual	Return Rate
1	South African government	5	8	60% (n=3)
2	Organised labour	6	11	83% (n=5)
3	Organised business	2	5	150% (n=3)
4	Mining industry professional associations	11	21	91% (n=10)
5	Mining companies	170	149	-12% (n=(-21))
6	Academia	0	6	100%
7	Other	0	9	100%
Total		194	209	

The results of the survey are presented under the following sub-headings:

- Profile of SAMI stakeholders represented.
- Perspectives about cannabis decriminalisation.
- Organisation attitude towards OHS since cannabis decriminalisation.
- Have the accidents/incidents increased since cannabis decriminalisation?
- Is there enough cannabis awareness and training?
- Perspectives about the existing drug policies and assessment procedures.
- Perspectives about existing drug assessment tools and procedures.
- Have employment policies been revised since cannabis decriminalisation?
- Stakeholder workshop invitation.

The data components with the associated key data variables surveyed and the questionnaire completion rate are summarized in **Table 8** below.

Table 8 Key data variables

#	Data Component	Key Variables	Completion Rate
1	Type of organisations represented	South African government	100% (n=209)
		Organised labour	
		Organised business	
		Academia	
		Mining industry professional association	
		Mining company	
		Other	
2	Designation	Occupational Hygienist	93.8% (n=196)
		Occupational Medical Practitioner	
		Organisation Spokesperson	
		Executive Manager	
		Senior Manager	
		Middle Manager	

		Production Supervisor	
		Mine Overseer	
		Mine Worker	
3	Number of work experience in current designation	Less than 2 years	99.5% (n=208)
		Between 2 and 5 years	
		Between 5 and 10 years	
		More than 10 years	
4	Awareness of latest legislation on cannabis decriminalisation in South Africa	Yes	100% (n=209)
		No	
5	Opinion about cannabis decriminalisation and impact on health and safety in mining	Good	97.6% (n=204)
		Bad	
		Not sure	
6	Organisation's attitude about cannabis decriminalisation and health and safety at mining operations	Something should be done about it	98.5% (n=206)
		Maybe something should be done about it	
		Nothing should be done about it	
		I don't know	
7	Number of accidents/incidents at mining operations since cannabis decriminalisation	Increased	98% (n=205)
		About the same	
		Decreased	
		I don't know	
8	Is there enough training and cannabis awareness	Yes	99% (n=207)
		No	
		Not sure	
9	Awareness of drug policies and assessment procedures	Yes	99.5% (n=208)
		No	
10	Change in drug testing assessment policies and procedures since cannabis decriminalisation	Yes	98% (n=205)
		No	
		Not sure	
11	Adequacy of existing drug policies and procedures to cover cannabis	Adequate	97% (n=203)
		Not Adequate	
		Not sure	
12	Revision of standard policies on drug management to include cannabis	Yes	97.6% (n=204)
		No	
		Maybe	
		I don't know	
13	Awareness of existing assessment tools and procedures for drugs	Yes	97.6% (n=204)
		No	
		Somewhat aware	
14	Effectiveness of existing assessment tools and procedures for drugs to cover cannabis	Effective	96.6% (n=202)
		Somewhat effective	
		Not effective	
		I don't know	
15	Should the existing assessment tools and procedures be revised to accommodate cannabis	Yes	97.6% (n=204)
		No	
		Maybe	
		I don't know	
16	Did the employment policies change since cannabis was decriminalised	Yes	98% (n=205)
		No	
		Not sure	
17	Interested in upcoming stakeholder workshop	Yes (Physical attendance)	99.5% (n=208)
		Yes (Virtual attendance)	
		No	

3.3.1.1 Profile of SAMI stakeholders represented

The representation of the participants by organisations type is presented in **Figure 4**. The mining companies had the highest representation consisting of 146 (70%) of the sample followed 27 (13%) from the MIPAs and 11 (5%) from organised labour. The remaining participants represented 8 (4%) from the SA government, 6 (3%) from the academia at, 2 (1%) from organised business and 9 (4%) from other. The participants representing other included unspecified organisations in health and safety departments, inspectorate, property department and sundry.

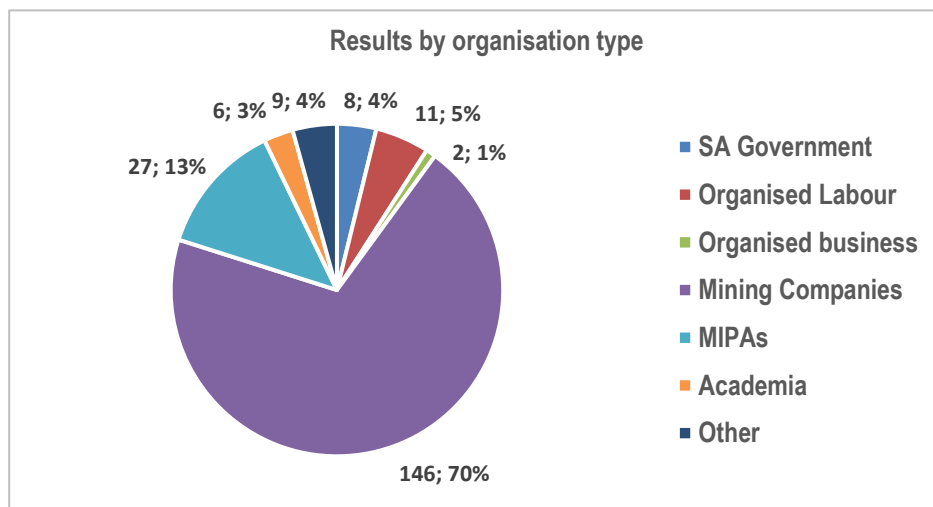


Figure 4 Results by organisations type

The representation of the survey participants by designation is presented in **Figure 5** below.

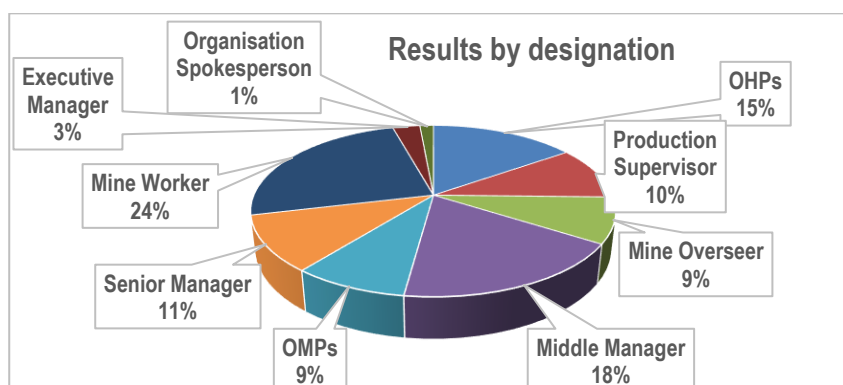


Figure 5 Results by designation type

As presented in **Figure 5** above, the mine workers were the most participants at 24% (n=51) followed by middle managers and Occupational Hygiene Practitioners (OHP) at

18% (n=38) and 15% (n=32) respectively. The middle tier representation was senior managers at 11% (n=22), production supervisors at 10% (n=21), mine overseers 9% (n=18) and Occupational Medical Practitioners (OMP) 9% (n=18) with the least represented being executive managers at 3% (n=6) and spokespersons at 1% (n=3).

The representation of the participants by work experience in the existing designation is presented in **Figure 6** below.

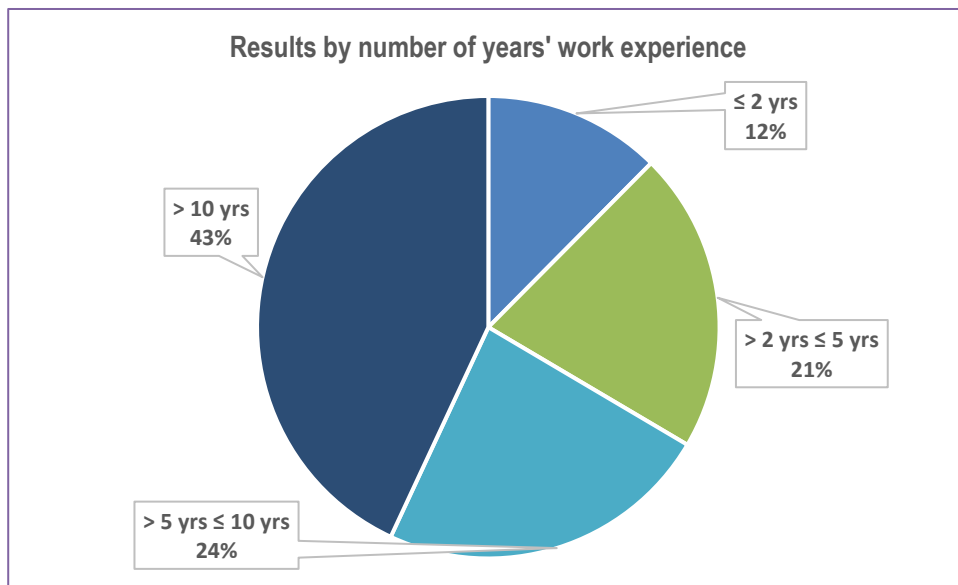


Figure 6 Results categorised by number of years' work experience

The statistics show that the highest number of participants were those with more than 10 years' experience in the current designations at 43% (n=90) followed by those between 5 and 10 years' experience at 24% (n=49), between 2 and 5 years' experience at 21% (n=44) and the least being those with less than 2 years' experience at 12% (n=26).

A comparison of the designations of participants from each organisations type represented is presented in **Figure 7** below. Out of the 8 participants who represented the SA government, the 5 were middle managers followed by an equal split of 1 participant each between OHPs, OMPs and senior managers. Out of the 11 participants who represented organised labour, 3 each were spokespersons and middle managers followed by 2 senior managers and 1 each of mine worker, OHP and production supervisors. Out of the 2 participants who represented organised business, 1 was a middle manager and the other an OHP.

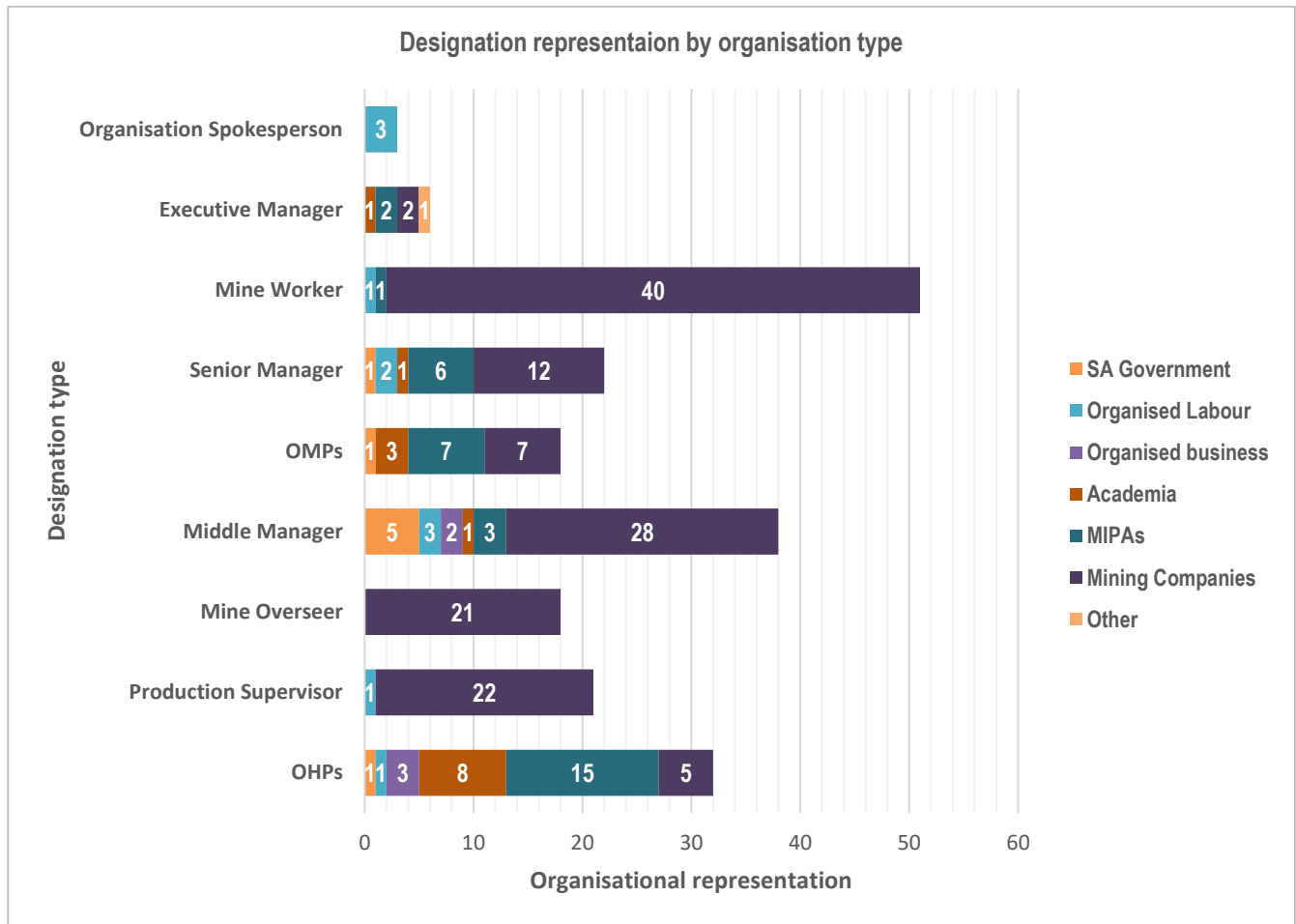


Figure 7 Designation representation by organisations type

The majority from academia were OMPs (n=3) and OHPs (n=3) and the rest were 1 each of executive, senior and middle managers. Out of the 27 participants who represented MIPAs 14 were OHPs, 7 OMPs, 6 senior managers and 1 mine worker. From the mining companies represented by 146 participants, the majority were miners (n=40) followed by a mix of production supervisors (n=22), mine overseers (n=21), senior managers (n=12), middle managers (n=28), OMP (n=7), OHP (n=15), and the least represented being executives (n=2). Only 1 executive represented other organisations.

A comparison of the designations of participants by how many years they have been in the existing role is presented in **Figure 8** below.

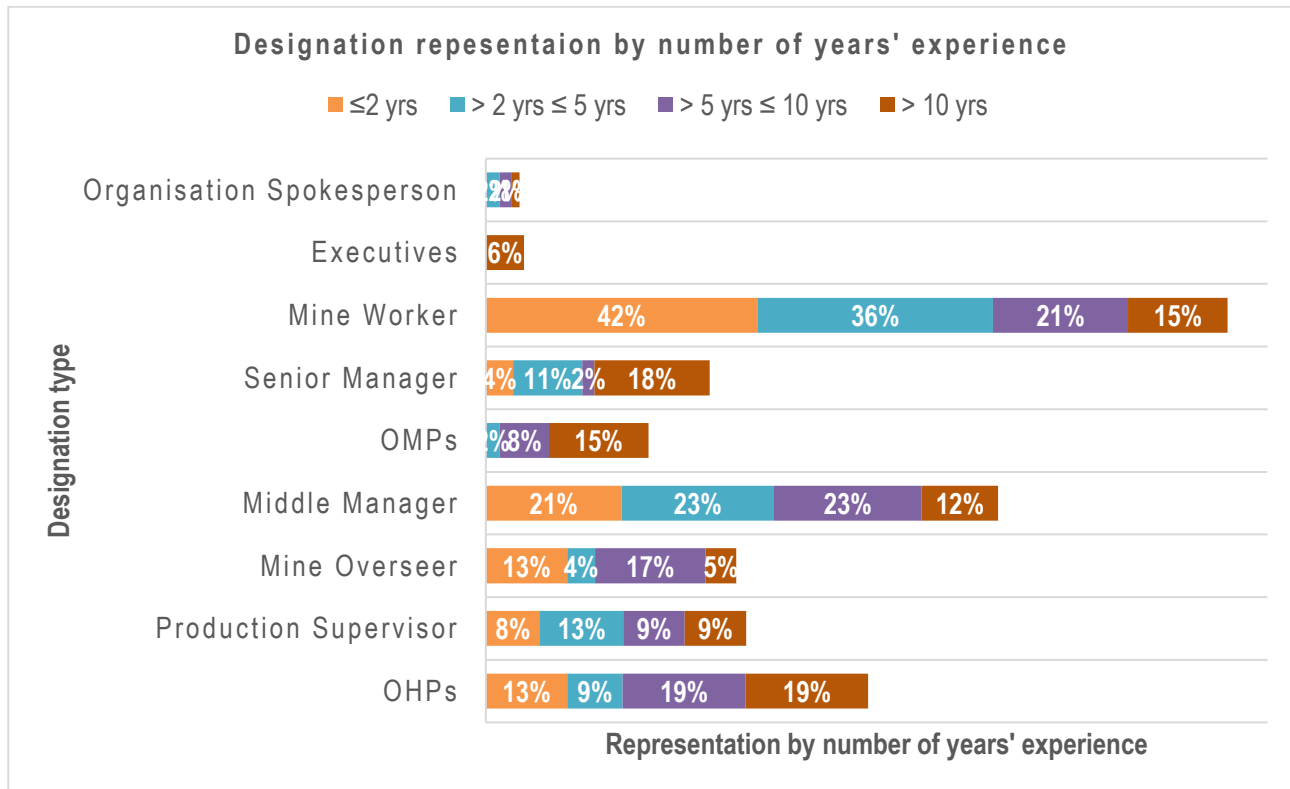


Figure 8 Designation representation by work experience

As can be seen from **Figure 8**, The longest serving designations of over 10 years are represented by OHPs at 19%, OMPs at 15%, executives at 6%, senior managers at 18%, mine overseers at 5%, middle managers at 12%, production supervisors at 9% and spokespersons at 1%. A higher median number of work experience between 2 to 5 years is represented by mine workers (36%), middle managers (23%), production managers (13%), senior managers (11%), OHPs (9%), Mine overseers (4%) and 2% each for spokespersons and OMPs.

3.3.1.2 Perspectives about cannabis decriminalisation

One of the key variables for this survey was to understand participants' thoughts on cannabis legislation. The data collected regarding perspectives on cannabis decriminalisation sought to gauge participants' opinions about the decriminalisation of cannabis in South Africa and its perceived impact on health and safety in the SAMI. Information was requested about the participants' awareness of cannabis decriminalisation in South Africa and whether they believed the OHS implications were good or bad. Participants were also requested to provide comments explaining their choices.

The results pertaining to the awareness of the latest legislation on cannabis decriminalisation in South African among the survey participants are presented in **Figure 9** below.

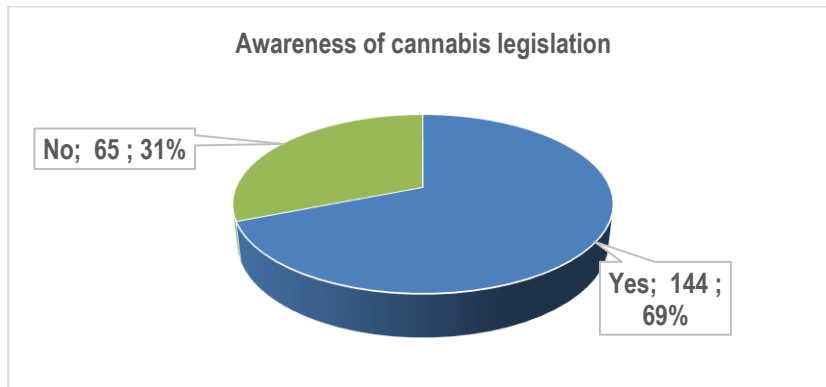


Figure 9 Awareness of cannabis legislation

As shown in **Figure 9**, the majority of the survey participants, 69% (N=144), were aware of the latest legislation on cannabis decriminalisation in South Africa. Only 31% (n=65) were not aware. The results regarding the participants' opinions on the impact of cannabis decriminalisation on health and safety in the SAMI are presented in **Figure 10** below.

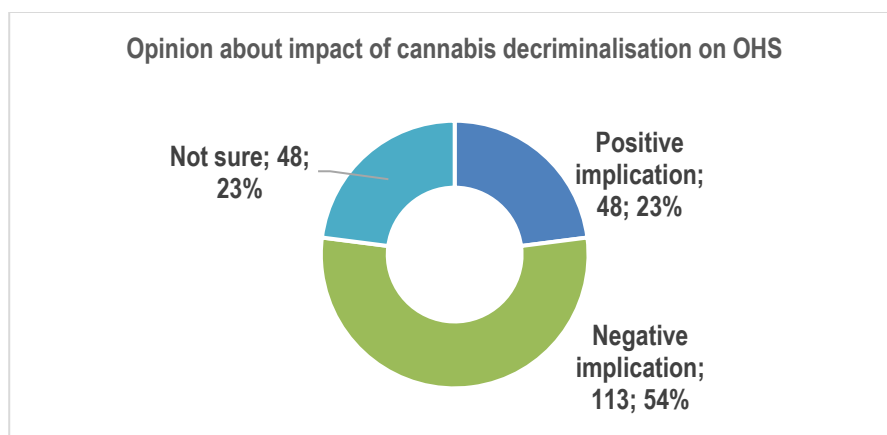


Figure 10 Opinion about impact of cannabis decriminalisation on OHS

The majority of the survey participants, 54% (N=113), thought that cannabis decriminalisation was bad for OHS in the SAMI. The remaining respondents either considered it a good idea or were unsure, (23%, n=48 each).

For a closer look at opinions of each designation regarding the impact of cannabis decriminalisation on OHS, **Figure 11** presents those results below.

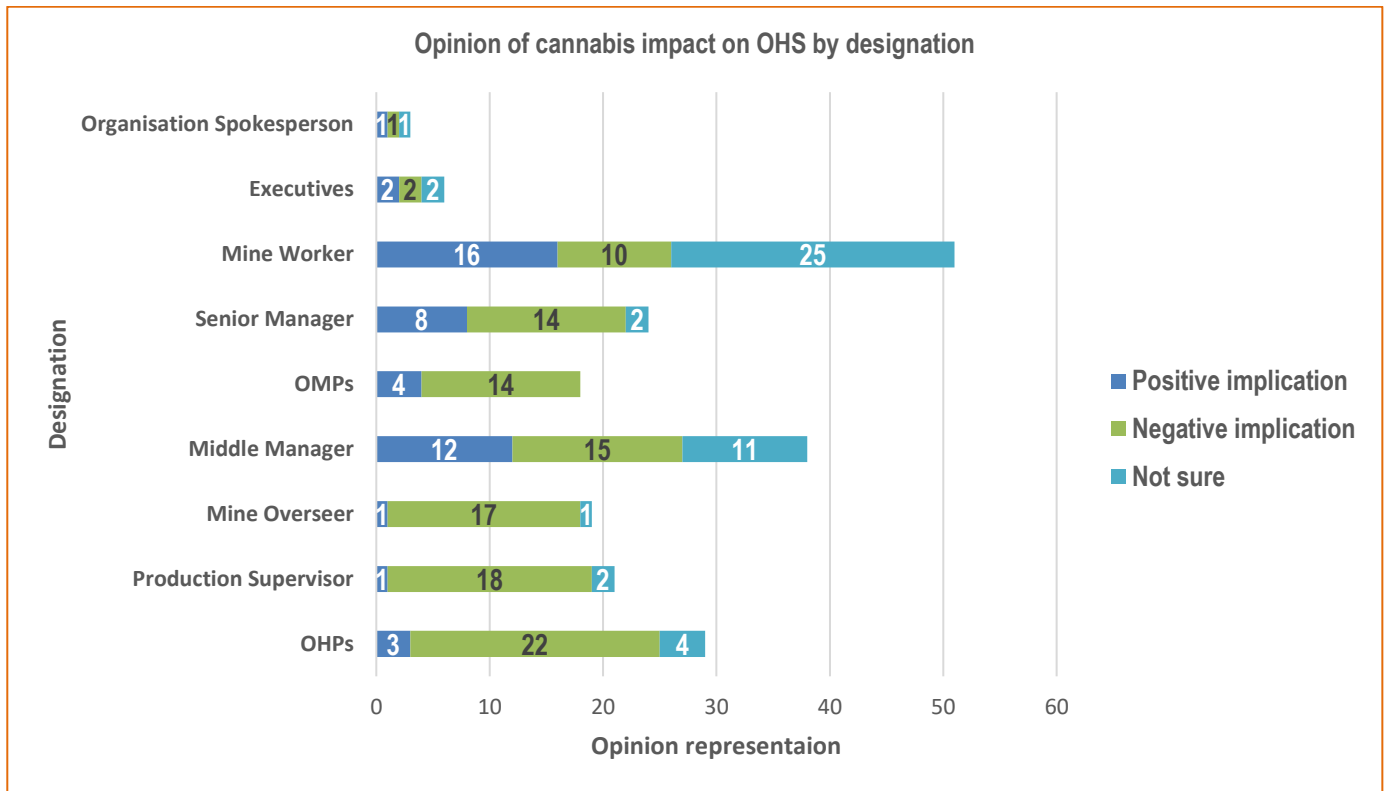


Figure 11 Opinion of cannabis impact on OHS by designation

With the exception of mine workers, the majority of participants such as OHP (n=22), OMP (n=14), executives (n=2), senior managers (n=14), middle managers (n=15), production supervisors (n=18), and mine overseers (n=17), believed that cannabis decriminalisation had a negative impact on OHS in the SAMI. A significant number of mine workers (n=25) and middle managers (n=11) expressed uncertainty regarding the impact of cannabis decriminalisation on the SAMI. Additionally, a notable portion of mine workers (n=16) and middle managers (12), perceived cannabis decriminalisation as beneficial for the SAMI.

The qualitative data of participants who had indicated that cannabis decriminalisation either had negative or positive impacts on OHS in the SAMI or those who had were not sure is attached as **Appendix 8.16, 8.17 and 8.18** respectively. Those who indicated that cannabis decriminalisation had adverse effects on OHS in the SAMI had safety concerns and cited the risk of increased injury and accidents. Others expressed anxiety about the unknown impact of the new freedom to smoke cannabis on OHS in the SAMI.

The survey participants who indicated that cannabis decriminalisation was beneficial for OHS in the SAMI mainly cited the medicinal benefits of cannabis especially for pain

management. The rest of the participants who were not sure of the impact expressed that they had not smoked before and that cannabis decriminalisation did not concern them and therefore had no opinion about its impact on OHS in the SAMI.

3.3.1.3 Organisation attitude towards OHS since cannabis decriminalisation

Another key variable of the survey was to understand the attitudes of the organisations represented in the survey after cannabis decriminalisation. The data collected regarding what the survey participants thought was the attitude of their organisations towards health and safety at mining operations since cannabis decriminalisation in South Africa is presented below. The participants were asked to indicate if their organisations believed something needed to be done about it.

The results regarding what the survey participants thought was the attitude of their organisations towards health and safety at mining operations since the decriminalisation of cannabis in South Africa are presented in **Table 8** below.

Table 9 Organisational attitude towards OHS since cannabis decriminalisation

Opinions	Something should be done about it	Maybe something should be done about it	Nothing should be done about it	I don't know	Totals
Representation					
SA Government	2	1	4	1	8
Organised Labour	5	1	5		11
Organised business	2			3	5
Academia	5			1	6
MIPAs	14	2	1	4	21
Mining Companies	78	10	24	37	149
Other				9	9
Totals	106	14	34	55	209

As shown in **Table 9**, over half of the participants (51%, n=106) thought that their organisation's attitude towards OHS since the decriminalisation of cannabis was proactive, believing that something should be done about it. 26% (n=55) did not know their organisation's attitude, and 16% (n=34) thought their organisation's attitude was to do nothing. The smallest group, 7% (n=14) thought that maybe something should or should not be done about it. A comparison of attitudes reported for each Organisation is presented in **Figure 12** below.

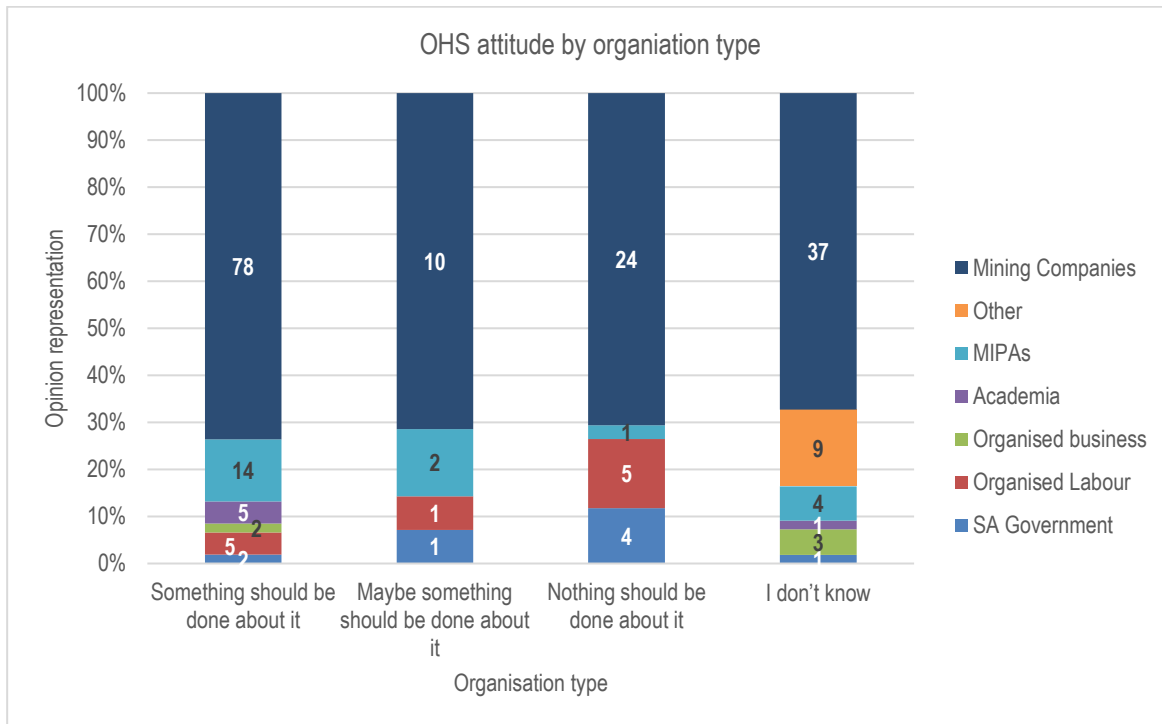


Figure 12 OHS attitude by organisations type

Results show that 4 representatives from the SA government indicated that nothing should be done about it. Organised labour's attitude was split between doing something about it and not doing anything as represented by 5 each. The majority of participants in organised business did not know what their organisation's attitude (n=3). The majority of participants from academia (n=5), the MIPAs (n=14) and the mining companies (n=78) thought that their organisation's attitude towards OHS is that something should be done about it.

A comparison of attitudes reported for each designation is shown in **Figure 13** below. The majority of participants who thought their organisation's attitude is to do something about it are the OHPs (n=26), followed by senior managers (n=16), production supervisors (n=17), middle managers (n=17), mine overseers (n=15) and OMPs (n=13). The majority of participants who did not know what their organisation's attitude towards OHS was where mine workers (n=32) and middle managers (n=9). The rest of the mine workers (n=11) and middle managers (n=11) indicated that their organisations' attitude towards OHS was to do nothing.

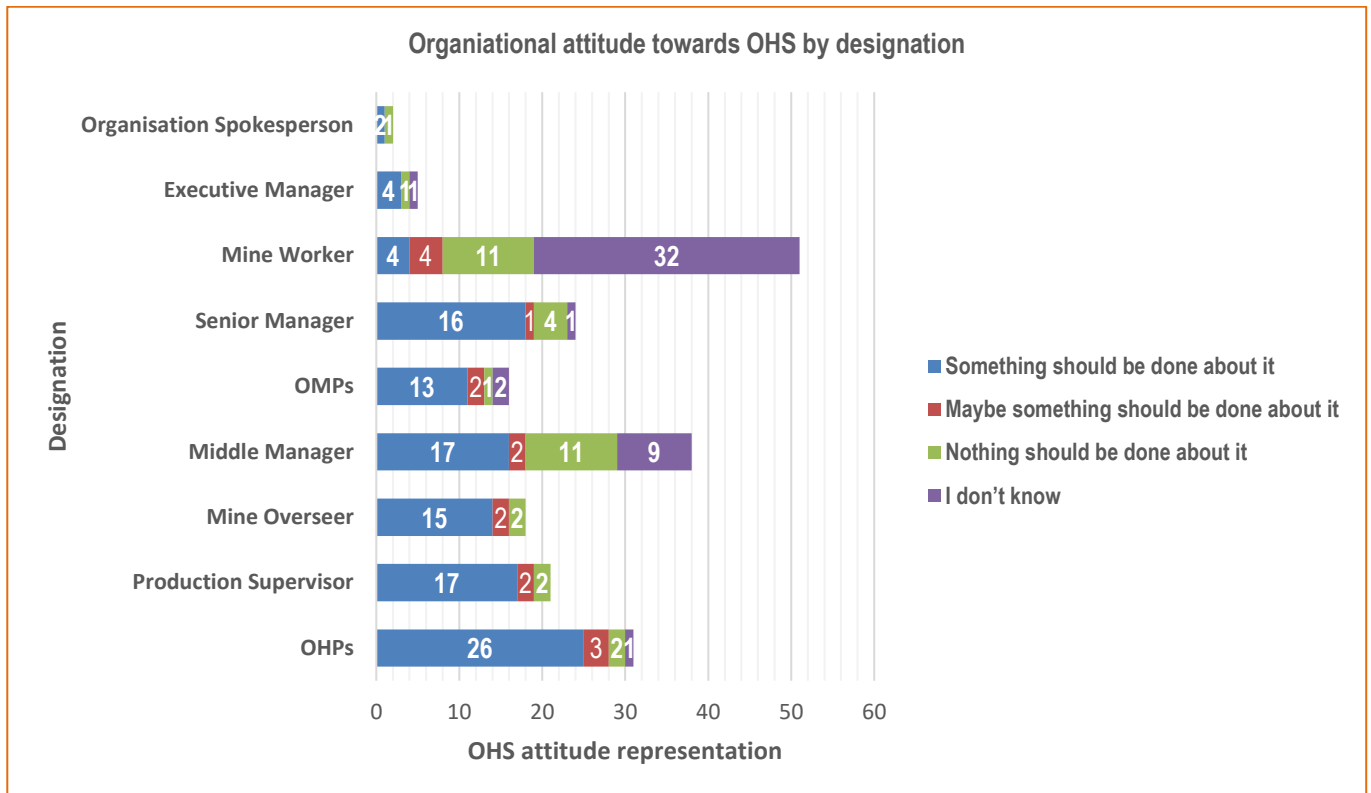


Figure 13 Organisational attitude towards OHS by designation

3.3.1.4 Have accidents/incidents increased since cannabis decriminalisation?

Linked to the organisations' attitudes after cannabis decriminalisation, it was necessary to understand if the survey participants thought that the accidents and incidents had increased. The data collected on the survey participants' opinions about the rate of accidents and incidents since cannabis was decriminalisation in South Africa is presented below. The information requested was for the participants to indicate if the numbers of incidents and accidents had increased, decreased or remained the same as before cannabis decriminalisation.

The results showing if survey participants knew about the rate of incidents and accidents in the SAMI since cannabis was decriminalised are presented in **Figure 14** below. The results show that the accidents and incidents since cannabis decriminalisation have remained about the same as before at 46% (n=96) although an equally high percentage of 41% (n=86) do not know whether accidents and incidents have increased.

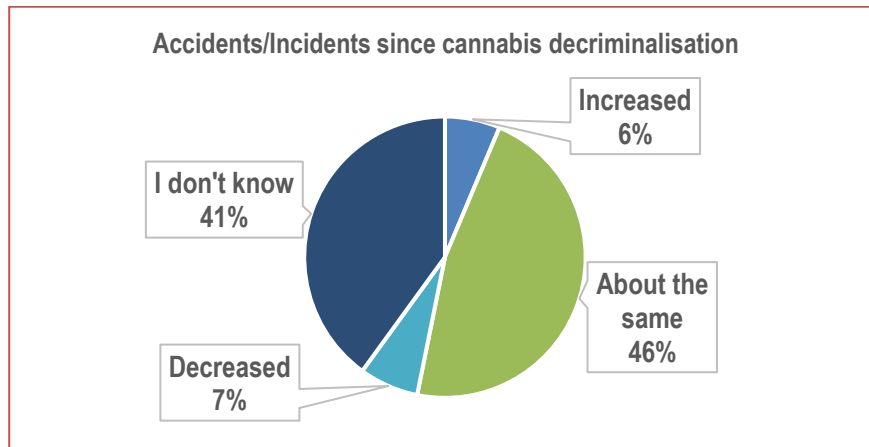


Figure 14 Number of accidents/incidents since cannabis decriminalisation

The participants who indicated that the incidents and accidents had either increased or decreased are relatively small at 6% (n=13) and 7% (n=14) respectively. The participants who indicated that accidents/incidents had decreased attributed did not attribute this to the decriminalisation of cannabis but rather to the various safety interventions and drives implemented to improve safety. Those who indicated that accidents/incidents had increased cited increased winch related accidents, slips and falls. However, they could not confirm attribution of the increases in accidents/incidents to cannabis decriminalisation.

3.3.1.5 Is there enough cannabis awareness and training?

Another fundamental variable that needed to be understood was the issue of cannabis awareness and training. The data presented in this section is to show what the survey participants' opinions were about the awareness and training of the impact of cannabis on workplace safety and productivity in the SAMI since cannabis decriminalisation in South Africa. The participants were requested to indicate if they thought that there was enough awareness and training about cannabis or not.

The results showing what the participants said about the awareness and training of the impact of cannabis on workplace safety and productivity in the SAMI are presented in **Figure 16** below.

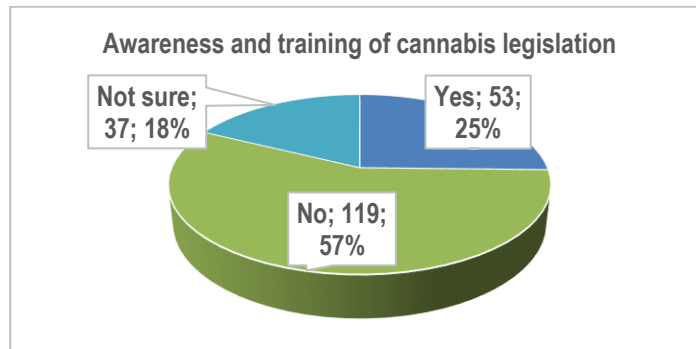


Figure 15 Cannabis awareness and training

Most participants (57%, n=119) indicated that there was no awareness and training about cannabis and its impact on safety and productivity in the SAMI. Only 25% (n=53) indicated that there was enough awareness and training, while the rest of the 18% (n=37) were not sure if there was enough awareness and training or not.

A comparison of organisations represented in this category is presented in **Figure 16** below. The majority of participants who indicated that there was not enough cannabis awareness and training were mining companies (n=94) and the MIPAs (n=15). The mining companies were also the majority of participants who indicated that there was enough awareness and training (n=40) and those who were not sure (n=15)

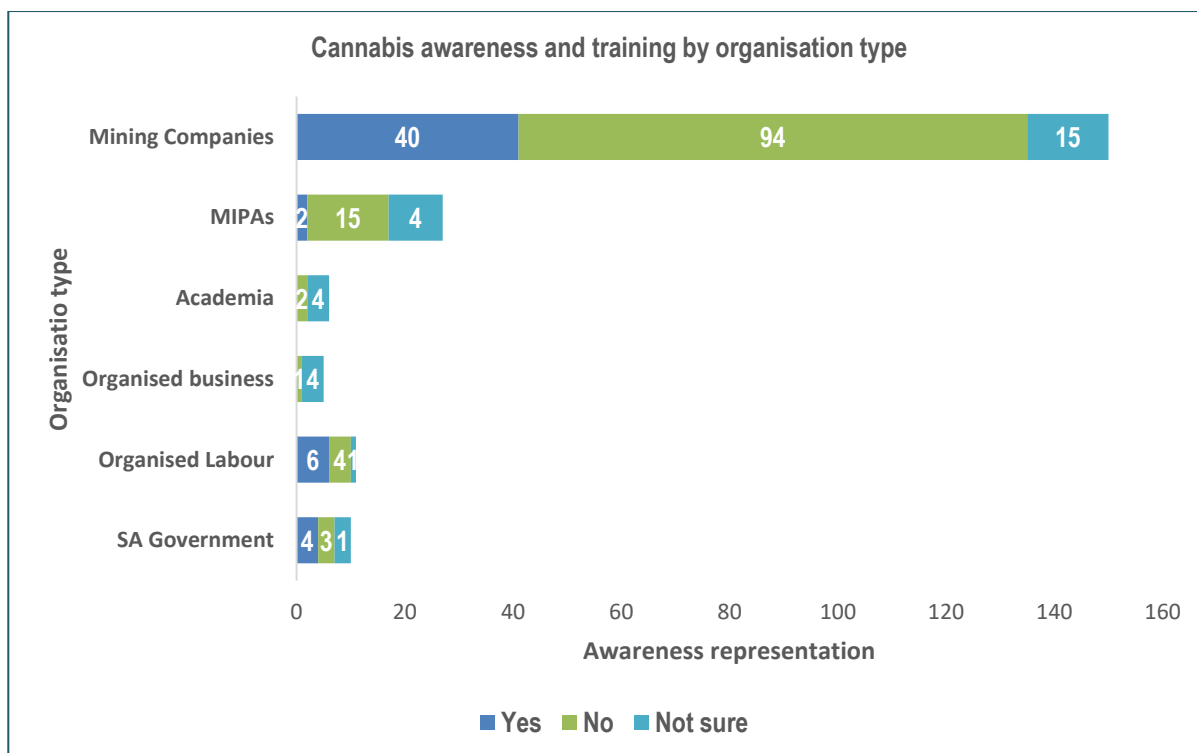


Figure 16 Cannabis awareness and training by organisations type

A comparison of designations represented in this category are presented in **Figure 17** below showing that the majority of mine workers (n=35), middle managers (n=22), senior managers (n=14), OHPs (n=15), Mine overseers (n=12), production supervisors (n=10), OMPs (n=9) and executives (n=5) thought that there was not enough awareness and training of the impact of cannabis on safety and productivity in the workplace. Only some production supervisors (n=11), middle managers & mine overseers with 10 and 8 participants respectively, 6 each of mine workers and senior managers indicated that there was enough training and awareness.

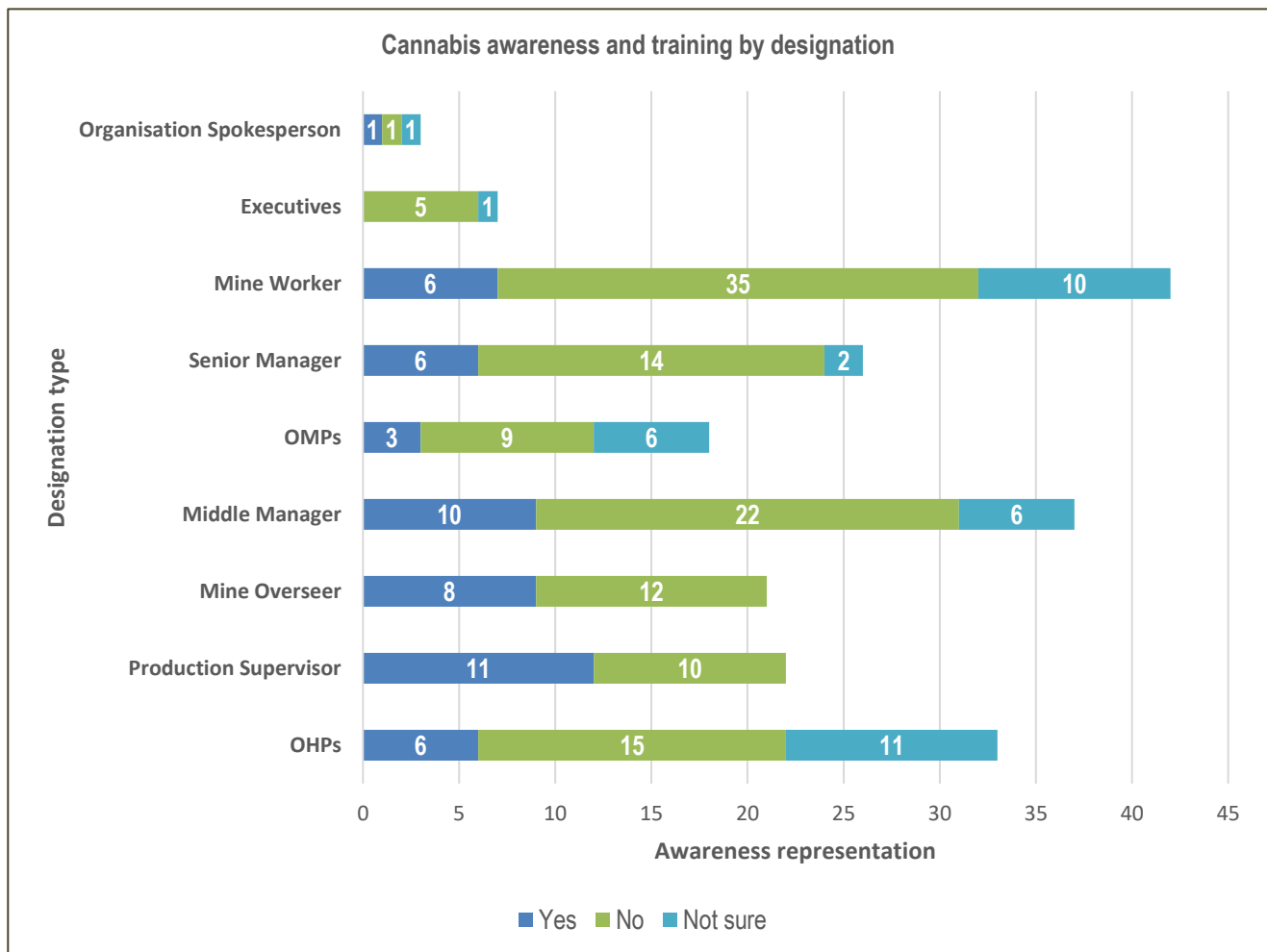


Figure 17 Cannabis awareness and training by designation

3.3.1.6 Perspectives about existing drug policies and assessment procedures

The results for the data collected on the perception of the survey participants regarding the existing drug testing policies and assessment procedures in the mining industry since cannabis was decriminalised are presented in the sub-section of the document. The participants were first asked if they were aware of the drug policies and assessment

procedures that are implemented in the mining industry. They then were asked if the drug testing policies and assessment procedures had been revised since cannabis decriminalisation. This was followed by soliciting information on what the participants' opinions were on the adequacy of the existing drug policies and procedures on drug management in the SAMI and if these should be revised to accommodate cannabis or not.

The results showing what the survey participants said about their awareness of drug testing policies and assessment procedures that have been implemented in the SAMI are presented in **Figure 19** below.

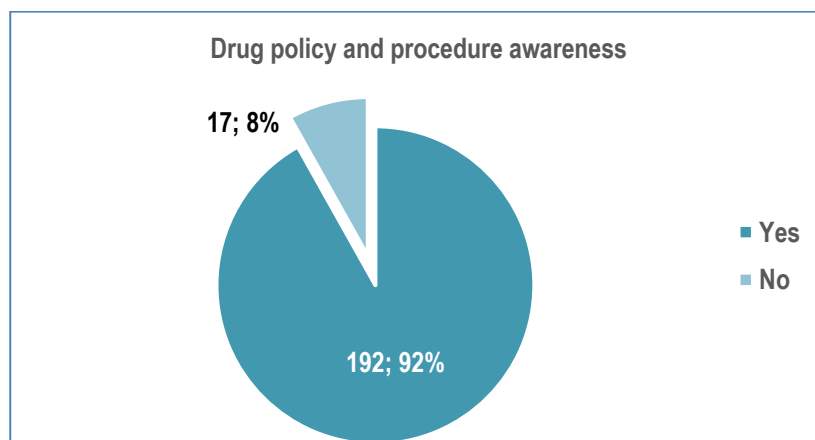


Figure 18 Drug policy and assessment procedures awareness

The results show that majority of participants at 92% (n=192) indicating that they were aware of the drug testing policies and assessment procedures that have been implemented in the SAMI, while only a small percentage of the participants at 8% (n=17) were not aware.

The results showing whether the survey participants thought that the existing drug testing policies and assessment procedures implemented in the SAMI had been revised since cannabis was decriminalised are presented in **Figure 19** below.

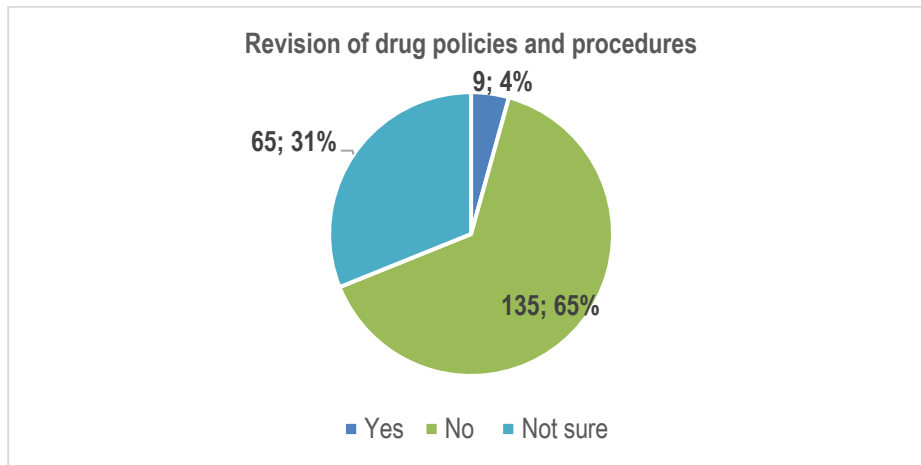


Figure 19 Revision of drug policies and procedures

The results in **Figure 19** show that about 65% (n=135) of participants did not perceive that the existing drug testing policies and assessment procedures implemented in the SAMI had been revised since cannabis was decriminalised. Those who were not sure about the revision of the existing drug testing policies and assessment procedures were 31% (n=65) with only 4% (n=9) affirming that there had been a revision to the existing policies and procedures.

An analysis of the organisations represented for those participants who affirmed that the policies and procedures had been revised is presented in **Figure 20** below.

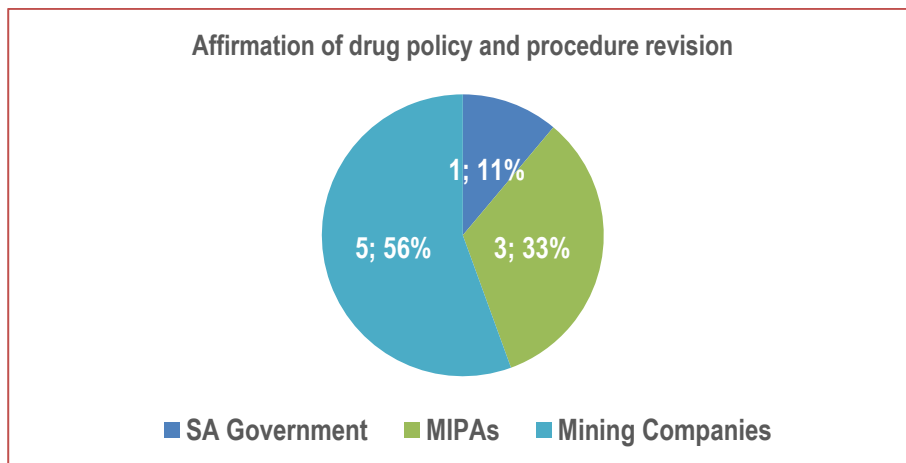


Figure 20 Affirmation of drug policies and procedures revision

The results in **Figure 20** show that 56% (n=5) of the 9 participants were from the mining companies, 33% (n=3) from the MIPAs and 11% (n=1) from the SA government affirmed that the existing drug testing policies and assessment procedures had been revised since cannabis was decriminalised. Those who affirmed that there had been policy

revisions referred to the code of practice regarding to substance abuse which had been reviewed, although no detail of what had been reviewed was provided. Others indicated that an approach to identify those who had consumed alcohol or drugs in the previous 72 hours had been implemented seeking to show a probability of intoxication. However, this was a general enhancement to the existing practices and not necessarily as a result of cannabis decriminalisation.

The results pertaining to the survey participants' perspectives regarding whether the existing drug testing policies and assessment procedures used for drug management in the SAMI are adequate to cover cannabis are presented in **Figure 21** below.

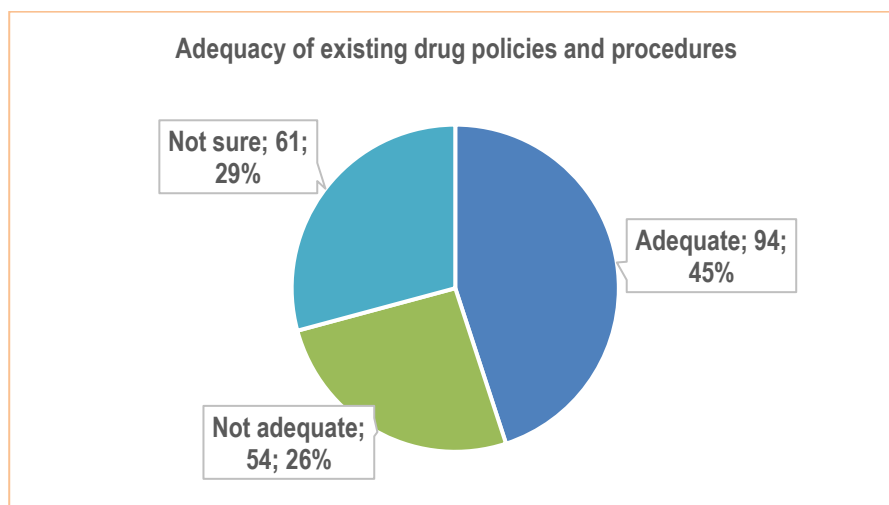


Figure 21 Perspectives about the adequacy of existing drug policies and procedures

Majority of the participants 45% (n=94), indicated that the existing drug testing policies and assessment procedures used for drug management in the SAMI are adequate to cover cannabis. The spread between those who were not sure (29%, n=61) and those who indicated that the policies and procedures were not adequate (26%, n=54) was minimal.

A comparison of the adequacy question by the designation of the survey participants is presented in **Figure 22** below. With the exception of the OMPs and OHPs (n=10) each, middle managers (n=14), senior managers (n=10) who thought that the drug policies and procedures are not adequate, the majority in all other professionals indicated that the existing drug testing policies and assessment procedures used for drug management in the SAMI are adequate enough to cover cannabis.

The rest of the participants were not sure if the drug policies and procedures were adequate or not with the majority of those being mine workers (n=32) followed by middle managers (n=12) and OHPs (n=6).

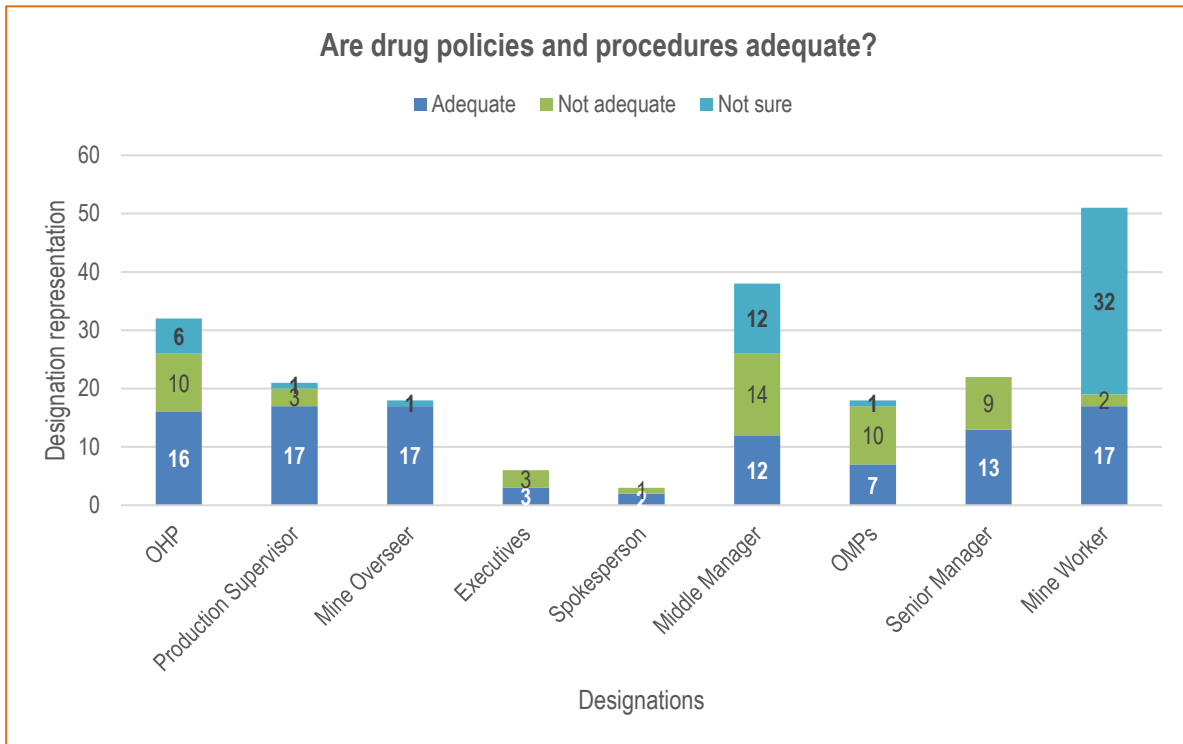


Figure 22 Adequacy of drug testing policies and procedures by designation

A comparison of the adequacy question by the work experience of the survey participants in the existing designation is presented in **Figure 23** below.

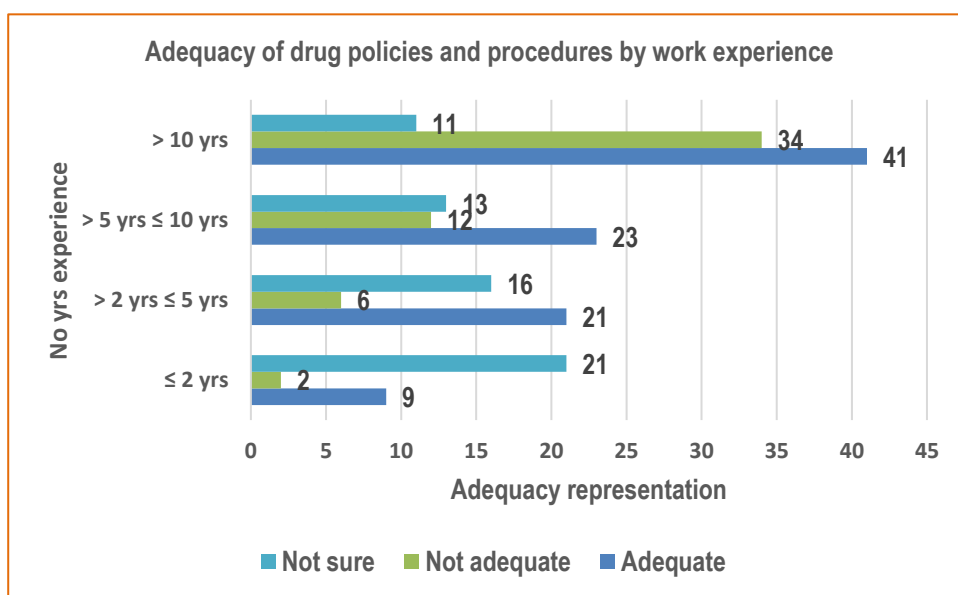


Figure 23 Adequacy of drug testing policies and procedures by work experience

In both responses of whether “adequate” or “not adequate”, the work experience mostly represented were those participants with more than ten years of experience in the current designation at (n=41) and (n=34) respectively. The majority of those who are not sure where participants with 2 years’ experience and less (n=21) and between 2 and 5 years (n=16).

The participants who had indicated that the existing drug testing policies and assessment procedures used for drug management in the SAMI are not adequate to cover cannabis cited outdated and generic policies, lack of clarity on legal limits, the large gaps in the frequency of test and that the existing testing processes were too complicated. A detailed list of the comments made is attached as **Appendix 8.19**.

The participants were then prompted to indicate whether they thought that the existing standard policies on drug management should be revised to accommodate cannabis in the SAMI. The results are presented in **Figure 24** below.

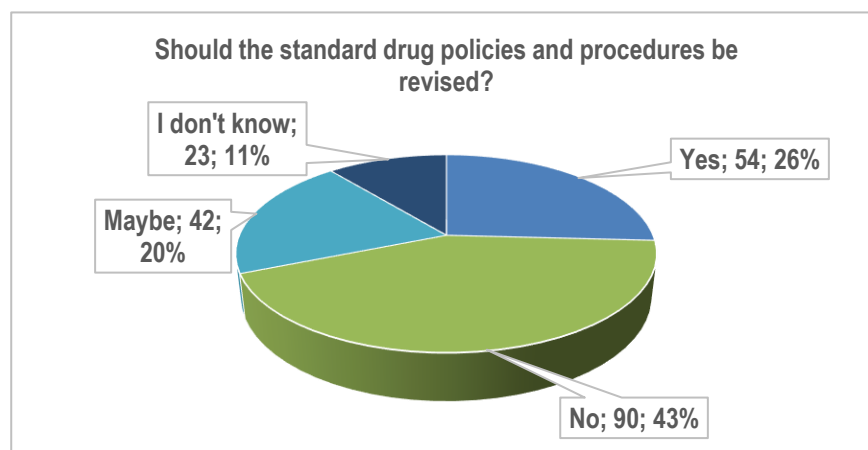


Figure 24 Should the standard drug policies and procedures be revised?

Most of the participants at 43% (n=90) did not think that the existing standard policies on drug management should be revised to accommodate cannabis in the SAMI. About 26% (n=54) thought that the standards policies should be revised while a good representation at 20% (n=42) expressed doubt while 11% (n=23) did not know.

The analysis of opinions about the revision of the standard policies and procedures by organisations type is presented in **Figure 25** below.

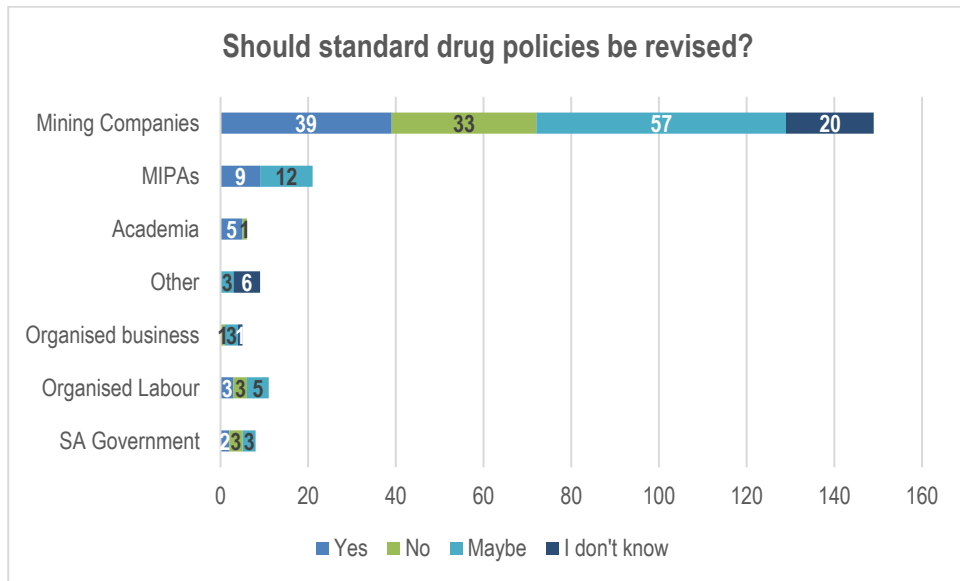


Figure 25 Drug policy revision by organisations type

Although the mining companies were the majority in all categories of responses, most of the participants were not sure if the existing standard policies on drug management should be revised to accommodate cannabis in the SAMI (n=57). Equally, most of the participants from the MIPAs were not sure if the existing standard policies should be revised (n=12) compared to those who did not think so (n=9). The responses for the rest of the participants were insignificant.

An analysis of opinions about the revision of the standard policies and procedures by designation is presented in **Figure 26** below. Most of the participants indicated that the drug policies should not be revised (OHP (n=20), production supervisors (n=17), mine overseers (n=15), mine workers (n=11), senior managers (n=10), OMPs (n=9) and middle managers (n=9)). However, there were equally significant numbers of the total participants who indicated that the drug policies should be revised (n=52), those who were doubtful that drug policies should be revised (n=42) and those who did not know (n=23).

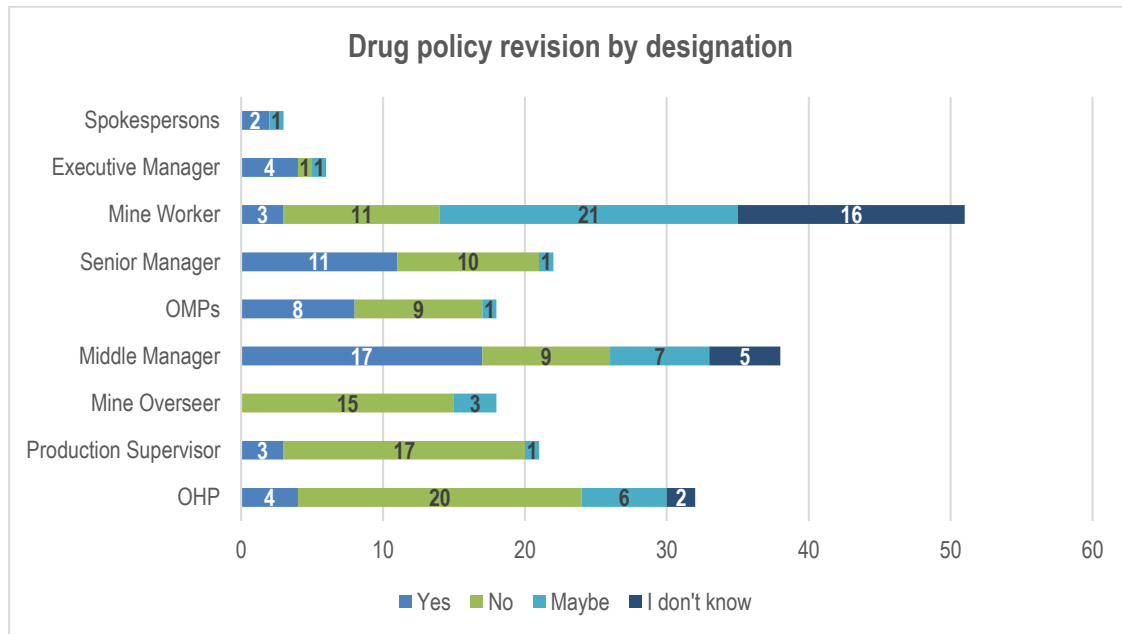


Figure 26 Drug policy revision by designation

An analysis of opinions about the revision of the standard policies and procedures by work experience type is presented in **Figure 27** below.

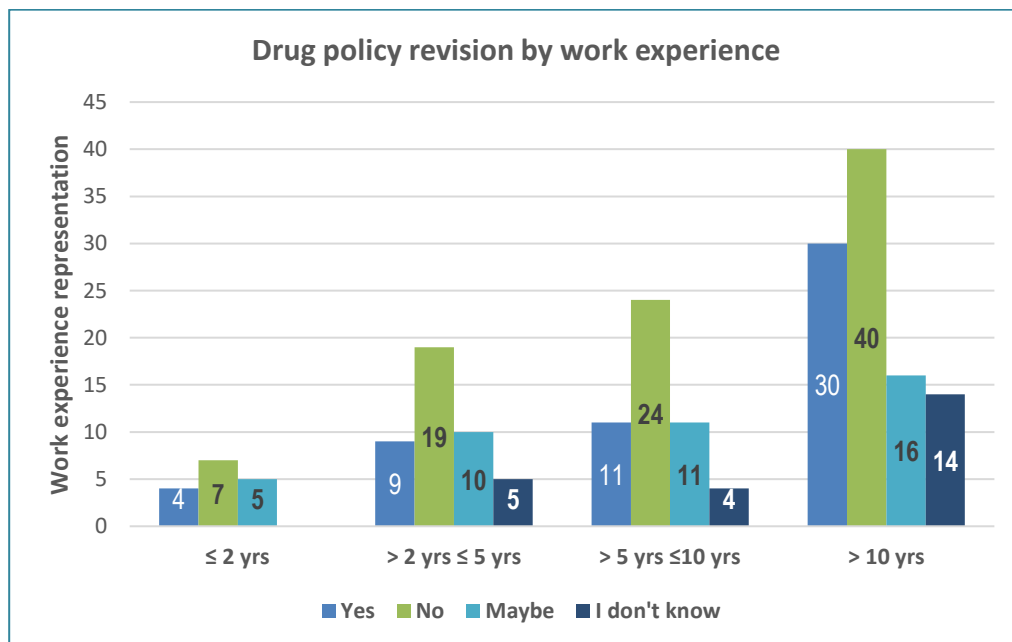


Figure 27 Drug policy revision by work experience

As with the previous statistics, most participants who indicated that the existing standard drug policies should not be revised were those with experience of more than 5 years in the current designation with a collective weight of n=64 participants compared to those who thought that drug policies should be revised (n=41) and those who were either not sure (n=27) or did not know (n=18).

The participants who had indicated that the existing standard policies on drug management in the SAMI should be revised to accommodate cannabis by specifying the legal limits to apply and guidance on the management of cannabis. A detailed list of the comments made is attached as **Appendix 8.20**.

3.3.1.7 Perspectives about existing assessment tools and procedures

This sub-section presents results for the data collected on the perception of the survey participants regarding the existing assessment tools and procedures that are currently used to detect the presence of drugs on employees in the SAMI. The participants were firstly asked if they were aware of the existing assessment tools and procedures that are used to detect the presence of drugs on employees in the SAMI. Then they were asked if they thought that the existing assessment tools and procedures used to detect the presence of drugs on employees were effective enough for cannabis use. This was then followed by soliciting information on the participants' opinions as to whether they thought that the existing assessment tools and procedures should be revised to accommodate cannabis or not in the SAMI.

The results showing what the survey participants said about the awareness of existing assessment tools and procedures currently used to detect the presence of drugs on employees in the SAMI are presented in **Figure 28** below.

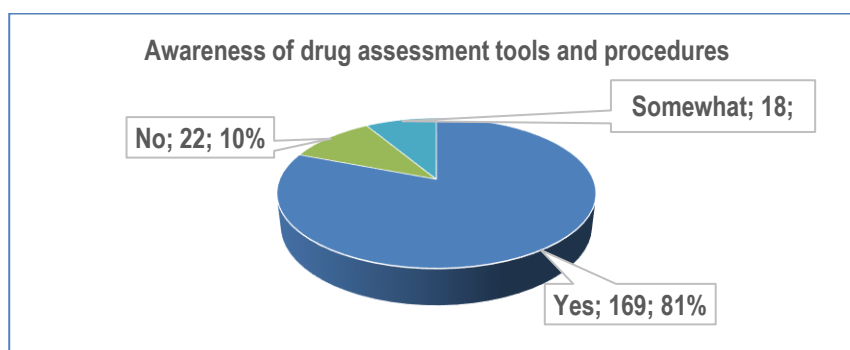


Figure 28 Awareness of the existing drug assessment tools and procedures

The results show that majority of the survey participants at 81 % (n=169) are aware of the of existing assessment tools and procedures currently used to detect the presence of drugs on employees in the SAMI while the rest are either unaware (10%, n=22), or somewhat aware (9%, n=18).

The results showing the survey participants' opinions about the effectiveness of the existing assessment tools and procedures used to detect the presence of drugs of employees in the SAMI are effective enough for cannabis use are presented in **Figure 29** below.

The results are distributed sparsely across the responses with most individuals believing that the assessment tools and procedures used to detect the presence of drugs of employees in the SAMI were somewhat effective (36%, n=74) followed by those who affirmed effectiveness (26%, n=55), those who did not know (20%, n=42) and those who indicated that the existing tools and procedures were not effective (18%, n=38).

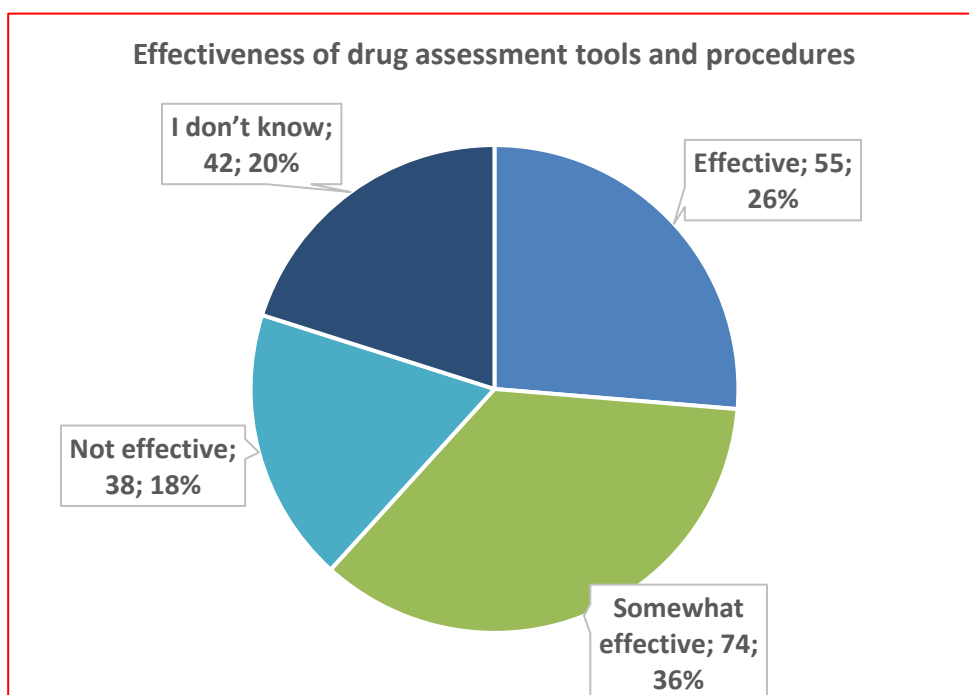


Figure 29 Effectiveness of the existing drug assessment tools and procedures

A comparison of the results by designation is presented in **Figure 30** below.

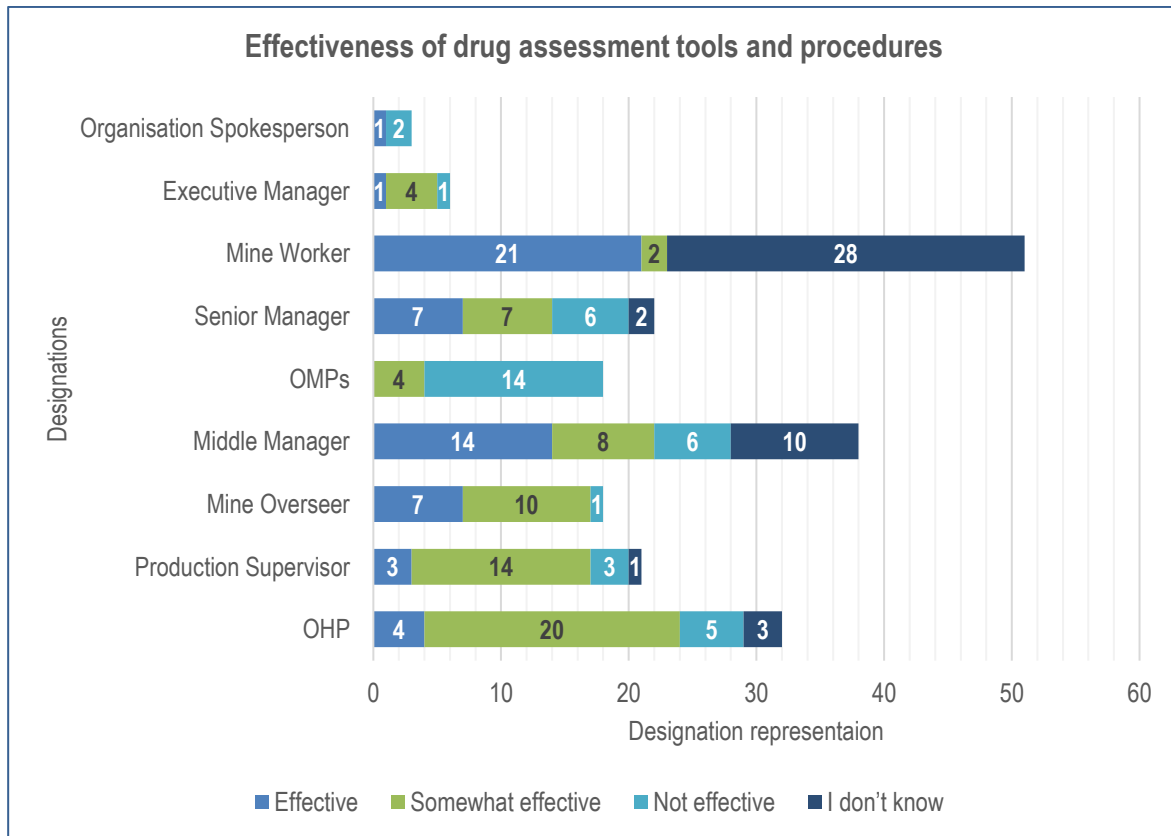


Figure 30 Effectiveness of existing drug assessment tools by work experience

Most survey participants who indicated that the existing assessment tools and procedures are somewhat effective enough for cannabis were OHPs (n=20), production supervisors (n=14) and mine overseers (n=10). Most of the mine workers (n=28) and middle managers (n=10) indicated that the existing assessment tools and procedures are effective enough for cannabis. However, only OMPs (n=14), senior managers (n=6), middle managers (n=6) and OHPs ((n=5) expressed that these tools and procedures are not effective enough for cannabis.

A comparison of the results by work experience is presented in **Figure 31** below. The highest representation of the participants indicating that the existing assessment tools and procedures are somewhat or not effective for cannabis is that of participants with over 10 years' experience (n=71) in their current designations with the lowest representation being that of participants with less years of experience across all the categories.

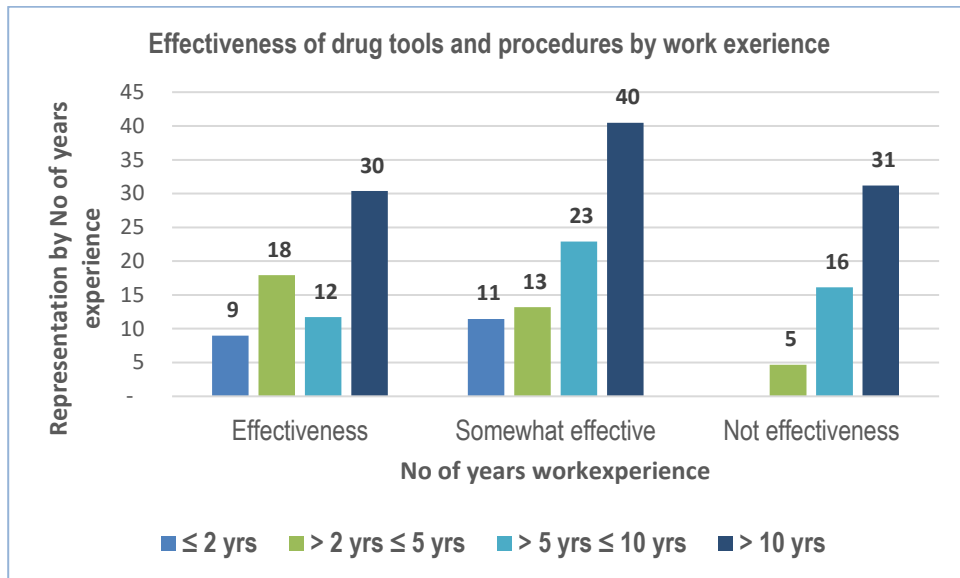


Figure 31 Effectiveness of existing drug assessment tools by work experience

The participants who indicated that the existing assessment tools and procedures were somewhat/not effective for cannabis indicated that the existing tools were not effective due to false positives and inaccurate test results. Others cited the cost of alternative tools to be unaffordable. A detailed list of the comments made is attached as **Appendix 8.21**.

The survey results reflecting participants' opinions on whether, the existing assessment tools and procedures used to detect the presence of drugs on employees should be revised to accommodate cannabis in the SAMI are presented in **Figure 32** below.

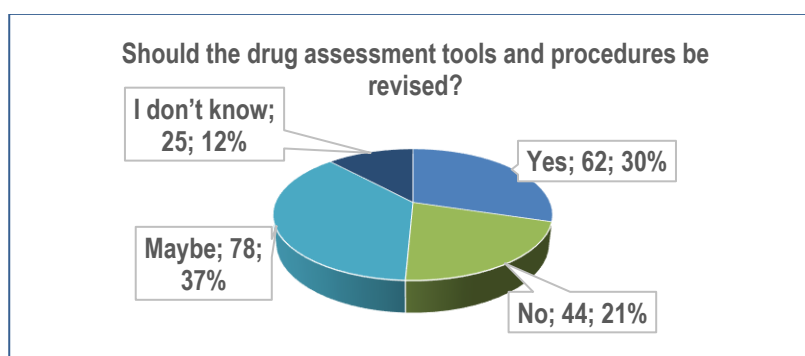


Figure 32 Should the drug assessment tools and procedures be revised?

The results for this question are closely contested across the available options with most of the participants uncertain about the revision of the drug assessment tools and procedures at 37% (n=78). This is followed by those who thought that the revision was

necessary at 30% (n=62), 21% (n=44) who thought it was unnecessary, and 12% (n=25) who were unsure if a revision should be made.

A comparison of results by designation in this category is presented in **Figure 33** below. From a set of participants who were not sure if the drug assessment tools and procedures should be revised, most were OHPs (n=20) followed by mine workers (n=15), production managers (n=14), middle managers (n=12) and mine overseers (n=8). From the set of participants who indicated that a revision should be done, most were OMPs (n=13) followed by senior managers and middle managers twelve each, while representation of those who expressed that a revision is not necessary were mostly represented by mine workers (n=11), mine overseers (n=9), middle managers (n=8), senior managers (n=6) and OHPs (n=5).

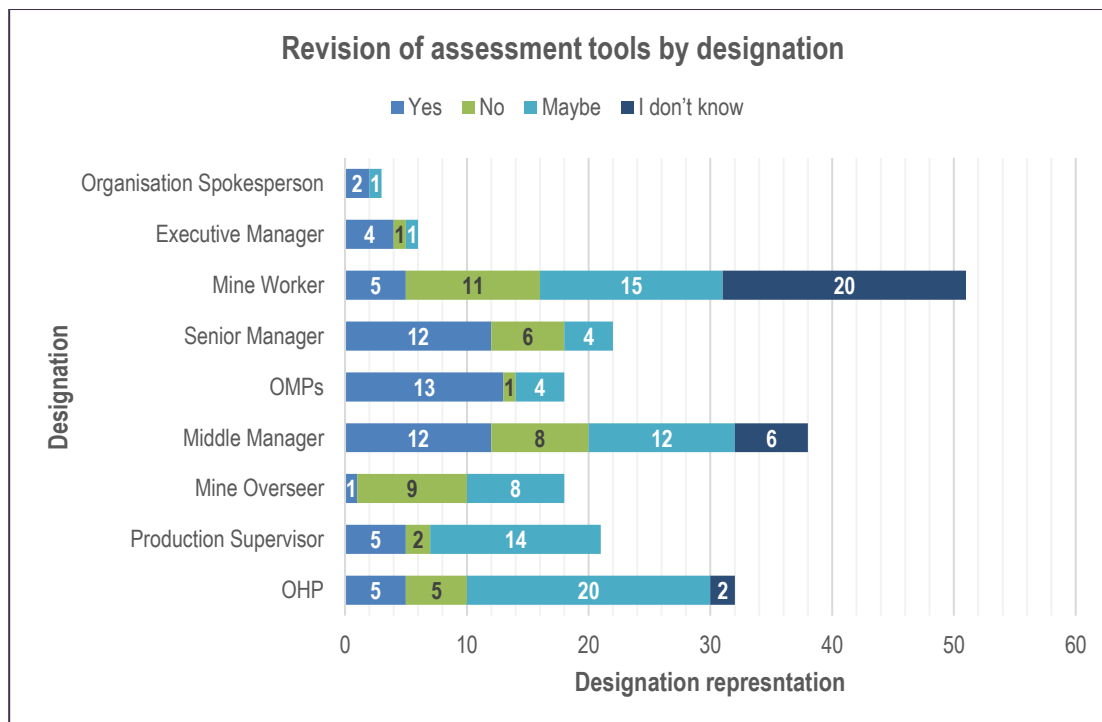


Figure 33 Revision of drug assessment tools and procedures by designation

The survey participants who indicated that the existing drug assessment tools and procedures used to detect drugs on employees in the SAMI should be revised to accommodate cannabis pointed mostly to the need for more guidance on the limits of cannabis, tools for testing, clarity on assessment procedures and the frequency of testing. A detailed list of the comments made is attached as **Appendix 8.22**.

3.3.1.8 Have employment policies been revised since cannabis decriminalisation?

For a holistic approach to understanding the full picture of the cannabis scenario, it was necessary to find out if the employment policies had been revised over the last six years since cannabis was decriminalised. The information requested was for the participants to indicate if the employment policies had been revised to specify the management of cannabis in the SAMI since its decriminalisation.

The results showing if survey participants thought that the employment policies in the SAMI had been revised to specify the management of cannabis since it was decriminalised are presented in **Figure 34** below.

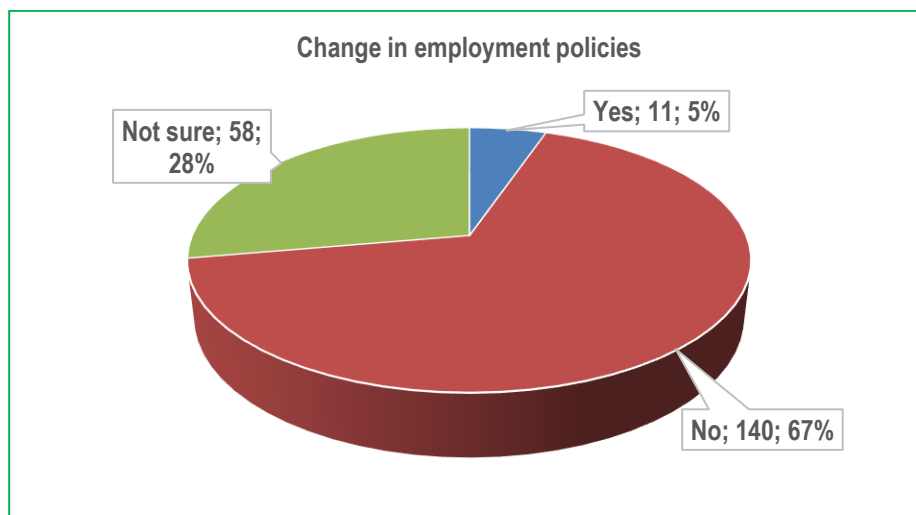


Figure 34 Change in employment policies

The evidence is clear from the opinions of most survey participants that the employment policies have not been revised since cannabis was decriminalised as indicated by 67% (n=140) of the participants. About 28% (n=58) were not sure and only 5% (n=11) indicated that the employment policies had been revised.

The analysis results for the organisations represented for this question are shown in **Figure 35** below. The affirmation that employment policies had not been revised to address cannabis management following its decriminalised came predominantly from mining companies representing 110 participants while 31 participants from the mining companies were unsure and eight stated that revisions had been made

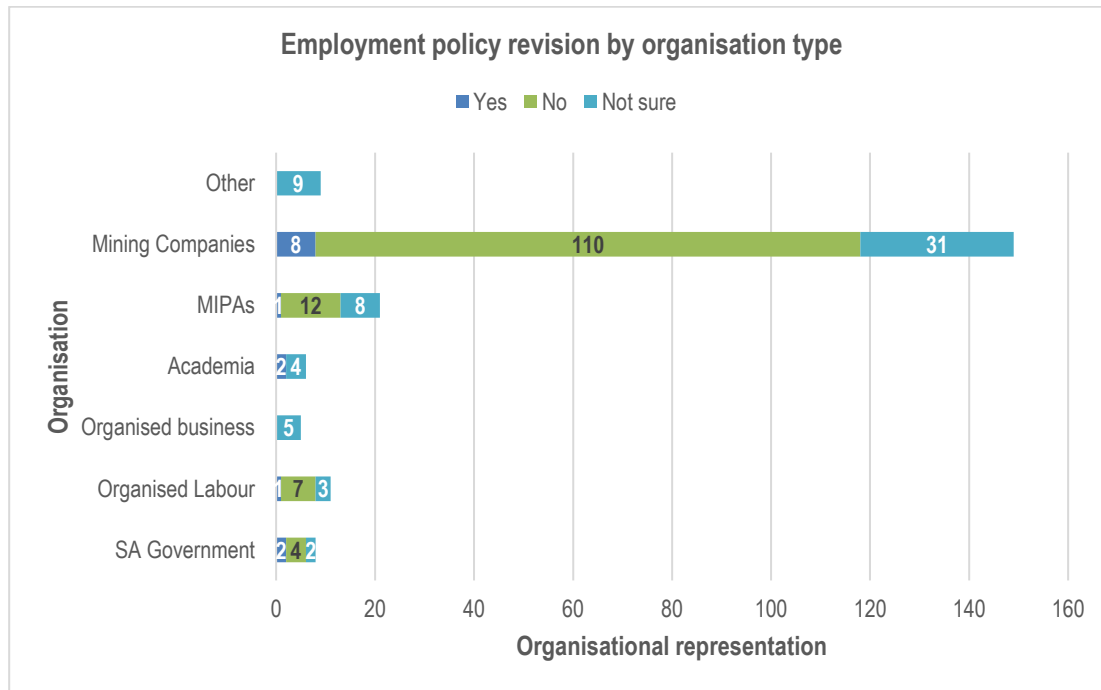


Figure 35 Employment policy revision by organisations type

B. DISCUSSION OF THE RESULTS

This section of the document discusses the statistical results obtained from the survey. As deduced from the presentations above, the results are based on opinions from a wide representation of stakeholders in the SAMI from all intended organisations and designations thereby eliminating any potential biases and improving validity of the survey results.

Perspective about cannabis decriminalisation

Awareness of cannabis decriminalisation was expected to be higher among participants due to the prevalence of drug use and its implications for OHS, particularly in heavy metal industries such as mining (Van Zyl, 2020). The adoption of zero-tolerance policies guided by the MHSA and adopted widely within mining operations, many workers are likely to be aware. The sentiments of most participants expressing concerns that cannabis decriminalisation had negative implications for OHS is drawn from the high prevalence of drug abuse within the mining industry.

Notably, the stakeholders involved in strategic and leadership roles such as the OHPs, OMPs, mine overseers, executives, senior managers, and some middle managers, generally perceive cannabis decriminalisation as detrimental to OHS in the SAMI. This

is expected as such members of the organisations perceive the cannabis impacts from the perspective of cost implications while general mine workers and some middle managers view it favourably because of the benefits it potentially brings them. Both perspectives offer valid arguments that should be carefully considered in devising solutions for cannabis management in the SAMI.

Comments provided by those who view cannabis decriminalisation unfavourably suggest that participants perceive high risks, especially in underground mines where impairment of cognitive abilities could pose significant dangers. Some equate the effects of cannabis to those of alcohol, noting its potential to impair reaction times and judgement, thereby increasing the risk of accidents. This affirms the findings in the literature for this study that cannabis has the potential to impair cognitive abilities and negatively impact productivity in the workplace (Carnide et al., 2023; Hinton & Asher, 2022; Louw & Johnson, 2020). Others express apprehension about the unknown impacts of cannabis on OHS consistent with the recency of cannabis and its perceived phantom implications. Additionally, concerns about drug dependency and its long-term effects on the mining industry are raised.

Conversely, comments from participants who view cannabis decriminalisation favourably indicate a belief in potential benefits, particularly for medical use in managing pain. This aligns with the literature findings about the benefits of cannabis which includes, amongst others, alimentary, medicinal and fiber uses (Balant et al., 2021). Others seem elated that cannabis users will not be discriminated against anymore now that cannabis has been decriminalised. Others believe it is beneficial because it will lead to more research, providing clarity on its benefits and how best it can be managed. Comments from participants who are unsure about the impact of cannabis decriminalisation on OHS show that such participants either do not use it and are therefore not interested in this subject at all or do not genuinely know what the impact is.

Organisational attitude about cannabis decriminalisation

The literature for this study reviewed that although cannabis was traditionally known for its many benefits to humankind (Alshaarawy et al., 2023; Erridge et al., 2023), this was overshadowed by its negative psychosis impacts on the human brain such that it is most popularly known for its disadvantages (Chayasirisobhon, 2020). As such, given the

perceived awareness of cannabis decriminalisation in the SAMI, it is expected that a larger percentage of survey participants would indicate that their organisation's attitude towards OHS is that something should be done about it. This expectation is particularly true for academia, mining companies and MIPAs, as these organisations understand the cost and health implications of cannabis better and are more likely to proactively want to address its effects on OHS in the workplace.

Similarly, it is anticipated that OHPs, OMPs, senior managers, mine overseers and production managers would think that something should be done about the impending implications of cannabis on OHS in the SAMI. These designations likely perceive the potential risks on OHS associated with the free use of cannabis more acutely due to their firsthand experience of the extent of drug abuse and dependencies in the mining industry.

Although it is an outlier, the results showing the SA government's tendency towards not doing something about OHS since cannabis was legalised is understood in the context that there is not enough alarming evidence yet to suggest that something should be done about the current approach to drug management in the SAMI. In the case of Organised labour unions, the split between doing something about OHS and not doing anything about it is expected as they serve the interests of both the employer and employee. Employers might want to address the issue proactively, while employees might prefer the status quo, appreciating the newfound freedom accorded by cannabis decriminalisation.

Similar to the results on whether cannabis decriminalisation has positive or negative implications for OHS, it is noteworthy that many mine workers and some middle managers are unsure of their organisation's attitude towards OHS since cannabis decriminalisation. This uncertainty could be attributed to the recency of cannabis decriminalisation and that plans to do something about it are still at strategic level and have not yet been cascaded down the levels within the organisations. This highlights the need for increased awareness and training of cannabis in the SAMI

Accidents/incident rate since cannabis decriminalisation

The last published industry safety statistics for the SAMI were for the 2022 period showing reductions in all categories of occupational fatalities, injuries and disease when

compared to the 2021 period, except for a slight increase in noise-induced hearing loss (MCSA, 2024). It is therefore expected that the results would show most participants indicating that the rate of accidents and incidents have remained constant or did not know if there had been a decrease or increase since cannabis was legalised. This is because there is no hard evidence yet attributing accidents and incidents to cannabis use. Furthermore, this is consistent with the fact that there are no case studies yet linking cannabis use to accidents and incidents in the SAMI. Hence a need to conduct specific case studies on the impact of cannabis on OHS in the SAMI.

The participants who indicated that the accidents and incidents had increased could not attribute such to cannabis use but rather to traditional hazards like rockfalls, slips, and winch related. The only participant who indicated that incidents and accidents had decreased attributed this to safety interventions and initiatives implemented in mining operations over time, which are unrelated to the cannabis discussion. This aligns with the attribution of improved OHS practices in the SAMI for the decrease in injuries, fatalities and disease reported for the 2022 period (MCSA, 2024).

Cannabis training and awareness

The results on whether there is enough awareness and training on the impact of cannabis on safety and productivity in the workplace present new insights into what is happening in the SAMI. The general perception is that there is not enough training and awareness although it appears that there is enough training and awareness in the SA government and Organised labour. Again, this could be attributable to policy-level awareness and training but may not necessarily be true at the operational level. This can be seen in the results for mining companies and the MIPAs who believe that there is not enough awareness and training as should be at the operational level. It is not surprising that academia, Organised business, and other organisations may not know if there is enough awareness and training about cannabis in the mining industry since they are far removed from such detail and may not be privy to operations in the SAMI.

Further confirmation of the hierarchy of implementation is evident in the results by operational-related designations, which show that OHPs, OMPs, executives, senior managers, middle managers, mine overseers, and mine workers think that there is not enough awareness and training on the impact of cannabis on safety and productivity in

the mining industry. This is an expected outcome given the recent enactment of the legislation and that awareness and training plans are still in their early stages.

The high representation of production managers indicating that there is enough awareness and training could be related to the specific production line level awareness and training which is always done with each batch of production. In this case, every worker is made aware of the implication of general intoxication regardless of the substance consumed.

Existing drug policies and procedures

It is expected that most of the survey participants would be aware of the existing drug policies and assessment procedures given that the zero-tolerance position on drug use is outlined in the MHSA and the LRA and stipulated as a condition of employment in the SAMI. It is also expected that many of the survey participants would believe that the drug testing policies and assessment procedures have not been revised since cannabis was decriminalised 6 years ago. There is no evidence to suggest that any revision has been issued in the form of legislation or guidance.

However, a few participants from the mining companies and the MIPAs who indicated that the drug testing policies and assessment procedures had been revised since cannabis was decriminalised provided clarity on what they meant. The one explanation was that the CoP with regards to substance use/abuse in the workplace had been reviewed. However, the participants did not confirm if the review had been implemented or not or whether cannabis was specifically addressed in the review. The other explanation was that an approach to identify users who had consumed cannabis in the previous 3 days had been implemented. Nevertheless, this approach cannot provide accurate results because of the half-life concept of cannabis that the test results for users would be non-negative, despite not being intoxicated as it may have been consumed and metabolized out of the body (Ashley et al., 2020).

The majority result on opinions that the existing policies and procedures on drug management in the SAMI are adequate to cover cannabis is reasonable given the contractual covenant of zero-tolerance on drug use in the industry. However, there was equally a high number of participants who were either not sure about the adequacy of the existing drug policies and procedures or thought that they were not effective. The

adequacy could be interpreted in terms of generalizability of implementation and the sufficiency of what was administered. The participants who were not sure of the adequacy, this could be the population of workers who do not use drugs and are therefore neither aware of the policies nor the procedures around cannabis management.

The reasons provided for thinking that the existing drug testing policies and assessment procedures used for drug management in the SAMI are not adequate to cover cannabis range widely across many perspectives. A sizable number of participants indicated that the existing drug policies and procedures were designed long before cannabis was legalised thereby rendering them obsolete and requiring revisions through risk assessments to adapt them more effectively to cannabis. This is linked to those participants who indicated that no research is currently being conducted to evaluate the existing drug policies and assessment procedures which is consistent with literature findings (Enslin, 2022) that there is little case research on the full impact of cannabis on drug policies and procedures in the SAMI.

Other participants alluded to the fact that the existing drug policies and assessment procedures are vague and generic casting doubt about their adequacy for cannabis even if they are adequate for other classes of drugs. This brings effect to the literature findings that cannabis measures are different from those used in other recreational drugs (Pearlson, Stevens & D'Souza, 2021).

Other participants indicated that, just as there are legal limits for alcohol in the bloodstream, there should also be limits for cannabis to standardise measurement. Associated with this is the comment on the already observed wrong positive urine test results while a worker is not necessarily intoxicated thereby deeming it inadequate. This observation is consistent with the literature findings that non-negative urine test results for cannabis do not imply intoxication (Hill et al., 2023). Other participants talked to the complex chemical composition of cannabis compared with other drugs making it complicated to administer an appropriate measure in the workplace.

Some participants also mentioned that the drug testing policies and procedures are largely ignored and only conducted annually, raising concerns about the adequacy of these policies and procedures. This shows that while the drug testing and assessment

procedures may be in place, their implementation is questionable, which nullifies the very purpose of policies and procedures. It was interesting to note a comment on the need to test for impairment rather than presence. The world is beginning to consider impairment testing as shown in the literature that technology is evolving towards that effect (Lechleiter 2024).

On the question of whether the standard policies on drug management should be revised to accommodate cannabis in the SAMI, although most of the participants felt that a revision was not necessary, those who thought that a revision was necessary and those who were not sure were well represented. This reflects the uncertainty around what the required standard should be especially as reflected in the high numbers of mine workers who are not sure about revising the existing standard policies on drug management or leaving them unchanged.

The comments from participants who felt that the existing standard policies on drug management should be revised echoed similar sentiments to those that indicated that the existing drug testing policies and assessment procedures are not adequate to cover cannabis. These concerns include the lack of sufficient research on the appropriate measurement standards for cannabis, the absence of legal limits for cannabis levels, and the fact that the existing policies are generic and lack specific guidance on cannabis management.

Other participants noted the need for guidance from the DMRE on the appropriate risk-based assessment and additional methods for cannabis management. A notable perspective raised in the comments was that organisations should distinguish management of medical cannabis users from users who abuse the substance and that clauses should be incorporated into existing policies for different management of cannabis for different work areas and occupations.

Existing drug assessment tools and procedures

As with the awareness of standard drug policies in the workplace, it is expected that most of the survey participants would be aware of the existing assessment tools and procedures currently used to detect the presence of drugs on employees in the SAMI. This is because of the enforcement of drug policies stipulated in the MHSA and the LRA and contracted as a condition of employment in the SAMI.

The results on the opinions of participants about the effectiveness of the existing assessment tools and procedures to detect cannabis on employees were rather interesting. The fact that most of the participants thought that the existing assessment tools and procedures are somewhat effective for cannabis, and that a sizable number either do not know or think that they are ineffective, is a clear indication that something is missing and should be addressed to achieve the required effectiveness.

The earlier argument about strategy versus operational implementation hierarchies, highlights a key disagreement: while the South African government views the existing assessment tools and procedures as effective for cannabis, mining companies hold a different perspective. It is expected from the SA government's point of view that there is no data yet to suggest that the existing assessment tools and procedures are ineffective and therefore no need for change in the guidance notes. On the other hand, most academics and OMPs think that the existing assessment tools and procedures are not effective while operationally, the OHPs, production managers and mine overseers consider them only partially effective.

More new insights were further provided in the qualitative data by the participants who thought that the existing assessment tools and procedures are not effective enough to detect cannabis on employees. A lot of comments talked to the fact that urine tests are the only tests conducted for all assessments and are now providing false results for cannabis. As mentioned earlier, research was established that non-negative results for cannabis do not mean that someone is intoxicated (Hill et al., 2023). The other inefficiency in the existing assessment tools mentioned is that urine tests do not provide concentration levels of the cannabinol or any active substance in the blood system which should determine intoxication. This is an important indicator that could potentially measure intoxication and length of cannabis use.

Some participants said that there was a need for complimentary assessment tools such as saliva tests, although another participant pointed out that saliva tests are too costly. This too was established in the literature for this study which showed that saliva, sweat and hair are less used modes of cannabis assessment due to the cost implication and delicacy of handling (Mørland & Bramness, 2020; Karschner et al., 2020). Others said that there was a need for more regular random tests for cannabis like the case is with alcohol testing. Many other participants mentioned the need for a legal limit by which

cannabis should be measured indicating that decriminalisation of cannabis should have been complimented with guidance on the allowable limits like how alcohol is treated. Other participants mentioned the need of testing for “under the influence” rather than the presence of a substance, which is the same as intoxication.

Regarding the revision of the existing assessment tools and procedures used to detect drugs on employees in the SAMI to accommodate cannabis, the uncertainty came through in the close representation in the participants’ opinions. It is expected that large numbers of participants would fall in the categories of uncertainty and not knowing due to the recency of the legislation which provided no clear guidance on the management of cannabis in the workplace. The mining companies represented by OHPs and mine workers, being the majority of those who are not sure if a revision is necessary, reflects the current status quo of uncertainly indicating a need for guidance.

The comments from survey participants who stated that the existing drug assessment tools and procedures in the SAMI should be revised to accommodate cannabis align with those who highlighted their inadequacy. The most popular comment was about the ineffectiveness of the urine tests which are currently used in the SAMI noting that there was need for complimentary tools for detecting the presence of cannabis on employees.

Others went further to suggest that research should be conducted to recommend specific assessment tools for cannabis be implemented such as impairment testing to ensure that only persons who are under its influence are identified. Other participants mentioned the frequency of cannabis assessments and follow-up on individuals who test positive , suggesting that these should be done as frequently as it is done for alcohol. Other comment related to the legal limits suggesting that a threshold for Delta-9-tetrahydrocannabinol (THC) like the alcohol thresholds be implemented in South Africa. Others commented that the existing drug assessment tools and procedures did not take cannabis into account when designed and should be revised to incorporate cannabis effectively.

Revision of employment policies since cannabis decriminalisation

Consistent with the survey results on whether the drug policies and procedures had been revised, the results on whether the existing employment policies had been revised to specify the management of cannabis since its decriminalisation showed most

participants indicating that no revision had been made. This confirms the lack of guidance even from an employment contractual perspective. The fact that most of these participants were from mining companies highlights the evidence of uncertainty surrounding the cannabis issue and its implications for OHS and workplace productivity, particularly given that mining companies are the most affected. The petition to the DMRE to guide on cannabis management is once more echoed in the context of employment policies. The focus should shift from a zero-tolerance approach to a risk-based approach for the management of cannabis.

Conclusions from Milestone 3

Generally, the SAMI stakeholders are aware of the latest legislation on the decriminalisation of cannabis in South Africa. They are also aware of the existing drug policies, assessment tools, and procedures that are used for the management of drugs in the SAMI. Furthermore, the stakeholders' perception of the existing standard drug policies is that they are effective enough to cover cannabis although there is a need for additional guidance about the actual standard by which cannabis should be managed, given its unique chemical composition. To this effect, there is a need for a risk-based approach to inform the effective management of cannabis in the workplace based on risk assessment inputs to potentially revise the existing policies.

On the contrary, the stakeholder's perception of the existing drug assessment tools and procedures used to detect drugs on employees are only effective to cover cannabis to some extent and fall short of complete effectiveness. There is no absolute confidence in their ability to detect the presence of cannabis on employees effectively. Therefore, there is a need for research and guidance into the alternative and complimentary assessment tools and procedures for the management of cannabis in the SAMI.

The decriminalisation of cannabis in South Africa was a significant change to the drug landscape particularly for the SAMI, where mining communities have long faced challenges related to drug abuse. Most of the SAMI stakeholders therefore expressed the view that cannabis decriminalisation has negative implications for OHS. Fortunately, the attitude of most organisations in the SAMI is that something should be done about it, with this stance represented at the highest level in organisations by senior management and professionals, which should strategically be filtered down to the lowest levels in due course. Although the general perception is that cannabis

decriminalisation is bad for OHS in the SAMI, most of the stakeholder's perspective is that OHS has not yet been compromised, as there is no evidence indicating an increase in accidents and incidents. This highlights a gap in knowledge about case studies associating cannabis use with OHS in the workplace as the actual impact is not yet known.

However, there is a need for more training and awareness of the impact of cannabis use on safety and workplace productivity as the current perspective of the SAMI stakeholders is that there is not enough cannabis awareness and training. There is also a need to review the existing employment contracts, which are currently generic, and might be obsolete and potentially revise them to clarify the management of cannabis in the workplace using a risk-based approach.

Overall, the survey conducted for this research study yielded its intended results following a rigorous methodology grounded in positivism, with no sample biases, thereby enhancing the study's validity.

3.4 MILESTONE 4

Results and Outcomes per Milestone

As indicated earlier, the aim of milestone 4 was to conduct a benchmarking exercise to determine the allowable blood level of cannabis in the body, using invasive and non-invasive assessments and tools, that would clarify as to when a person using cannabis for various purposes would pose a safety risk to him or herself or others in the workplace.

It was established in milestone 2 that the employer is allowed to impose Regulation 2A of the OHSA which says that no persons who is or appears to be under the influence of intoxicating liquor or drugs is permitted to enter or remain at a workplace. The legal framework is further supported by the LRA in Schedule 8, s3(1) which indicates that employers must generate rules of standard conduct required by employees and holds that dismissal is not unfair if it relates to misconduct (Section 188(1)) based on the pre-defined code of good practice (Schedule 8, s7). This implies that the employer is allowed to set out any standards to which employees must consent.

In terms of the Cannabis for Private Purpose Act No 7 of 2024, which allows an adult to possess or use cannabis in the private place and for private purposes, an amendment was issued to the National Road Traffic Act No 93 of 1996 (NRTA) to guide on legal blood limits allowable for persons and professional drivers. As with alcohol limits, cannabis blood limits under the NRTA serve as a benchmark for legal adoption in South Africa. However, it is necessary to determine the risk threshold by which a cannabis user is deemed to be intoxicated and cannot perform the required duties in the workplace because they are a safety danger risk to themselves and others.

There are several studies that have demonstrated the association of cannabis use with impairment in cognition such as memory loss, psychomotor and the executive functioning of the brain which can impact the driving ability and lead to collisions with injury or even deaths (Savigny, 2021; Preuss et al., 2021; Campeny et al., 2020). Other studies have shown that cannabis use can potentially lead to mental health disorders such as psychosis, anxiety, and depression, in addition to respiratory and cardiovascular diseases (Hasn et al., 2020; Campeny et al., 2020; Leung et al., 2020; Jouanjus et al., 2017). Another set of studies have identified risk thresholds for the levels of exposure to cannabis resulting in intoxication at different doses. Mostly or these are case-control studies which compared cannabis use in crash-involved drivers with non-crash-involved drivers (Van der Pol et al., 2013; Santaella-Tenorio et al., 2019; Compton et al., 2019).

Many meta-analyses have published studies showing the association of cannabis consumption with impairment. These studies have shown increases in crash risk for users of cannabis at different dose limits with estimated odds ranging from insignificant to over two (Gadegbeku et al., 2011; Li et al., 2013; Bernhoft et al., 2012; Hels et al., 2013; Drummer et al., 2004; Poulsen et al., 2014; Elvik, 2013; Martin et al., 2017; Asbridge et al., 2012).

Thus, a systematic review of literature and meta-analysis techniques were used to pool the ORs of studies that have shown risk thresholds for cannabis use from the studies that suggested the cut-off limits for safety and intoxication or impairment and the probability of accidents.

3.4.1.1 Study selection

The database search returned 7,620 records. After the removal of 4,352 records before screening, 3,268 studies underwent screening by title/abstract. This led to a further exclusion of 3,221 records with 47 moving forward to full text screening. A total of three case control studies (Martin et al., 2017; Gadegbeku et al., 2011; Laumon et al., 2005), one forensic case study (Drummer et al., 2020) and one prospective case study (Brubacher et al., 2019) were included in this review.

3.4.1.2 Study characteristics

The studies included in the review comprised a total of 27,758 records of drivers who had been involved in vehicle crashes across France, Canada, and Australia. Sample data had been pooled from trauma Centres in British Columbia (Brubacher et al., 2019), State of Victoria hospital (Drummer et al., 2020) and others from police procedures for fatal accidents in Metropolitan France (Martin et al., 2017; Gadegbeku et al., 2011; Laumon et al., 2005). All the studies had used whole blood as a biomarker for their reviews and had utilised the logistic regression to assess the differences in ORs for each cut-off limit of cannabis usage.

Table 10 summarizes the characteristics of the studies included in this review.

Table 10 Study characteristics

Study #	Name	Title	Sample Size	Location	Type	Biomarker	Statistical analysis
1	Drummer et al., 2020	Odds of culpability associated with use of impairing drugs in injured drivers in Victoria, Australia	5,000	Australia	Forensic case control	Blood	Logistic regression
2	Brubacher et al., 2019	Cannabis use as a risk factor for causing motor vehicle crashes: a prospective study	3,005	Canada	Prospective case control	Blood	Logistic regression
3	Martin et al., 2017	Cannabis, alcohol, and fatal road accidents.	4,059	France	Case control	Blood	Logistic regression
4	Laumon et al., 2005	Cannabis intoxication and fatal road crashes in France: population-based case-control study	10,748	France	Case control	Blood	Unconditional logistic regression
5	Gadegbeku et al., 2011	Responsibility study: main illicit psychoactive substances among car drivers involved in fatal road crashes	4,946	France	Case control	Blood	Logistic regression

3.4.1.3 Meta-analysis

The results of the common effect inverse-variance model showed a significant result in the pooled ORs estimated at an overall value of 2.03, a 95% CI of 1.770 and an insignificant standard deviation ($p=0.000$) as shown in **Figure 36 below**. This suggests that when THC was present in the blood of all driver categories, at doses of greater than 1 ng/ml and in the absence of any other potentially impairing substance, the odds of accident or culpability were 2.03 times higher than in the control group ($P=0.000$).

However, the increase in odds was most apparent at higher blood concentrations as is evident in the Drummer et al., (2020) study where the OR was 11 for THC greater than 10 ng/ml dosage. The results showed that THC levels of less than 1 ng/ml had insignificant odds in relation to accidents or culpability as can be seen in the negative CIs from studies by Laumon et al. (2005) and Brubacher et al. (2019). The THC cut-off dose limits included in this meta-analysis are presented in **Table 11** showing values ranging from less than 1 ng/ml to greater than 10 ng/ml.

Of much interest to note is the statistic in the Forest Plot presented in **Figure 36** and the pooled aggregated data in **Figure 37** below showing that the highest pooled weight was attributable to study 11 (15.95%) and study 14 (11.95) by Laumon et al., (2005) and Gadegbeku et al., (2011) respectively. These studies demonstrated that THC blood levels of between 1 ng/ml and 2 ng/ml had the highest 95% CI and were therefore weighted more heavily than the other studies with different THC doses.

Table 11 Source effects (Odds Ratios) and 95% CI

Study	Source	Cannabis Limits	or	lci	uci	lnor	lnlci	lnuci	_ES	_seES	_LCI	_UCI	_WT
1	Drummer et al., 2020	1 – 4.9 ng/ml	1.7	1	3.1	0.5306	0.0000	1.1314	0.5306	0.2886	0.0000	1.1314	5.83
2	Drummer et al., 2020	5 – 9.9 ng/ml	3.3	1.4	9.1	1.1939	0.3365	2.2083	1.1939	0.4775	0.3365	2.2083	2.13
3	Drummer et al., 2020	> 10 ng/ml	11	1.5	456	2.3979	0.4055	6.1225	2.3979	1.4585	0.4055	6.1225	0.23
4	Brubacher et al., 2019	1 – 2 ng/ml	1.53	0.9	2.6	0.4253	-0.1054	0.9555	0.4253	0.2706	-0.1054	0.9555	6.63
5	Brubacher et al., 2019	> 1 – 5 ng/ml	1.59	0.9	2.82	0.4637	-0.1054	1.0367	0.4637	0.2914	-0.1054	1.0367	5.72
6	Brubacher et al., 2019	> 5 ng/ml	2.29	0.83	8.01	0.8286	-0.1863	2.0807	0.8286	0.5783	-0.1863	2.0807	1.45
7	Martin et al., 2017	>=1 - 3 ng/ml	2.59	1.7	3.86	0.9517	0.5306	1.3507	0.9517	0.2092	0.5306	1.3507	11.1
8	Martin et al., 2017	>=3 - 5 ng/ml	7.41	3	18.5	2.0028	1.0986	2.9178	2.0028	0.4641	1.0986	2.9178	2.25
9	Martin et al., 2017	> 5 ng/ml	3.95	2.24	6.96	1.3737	0.8065	1.9402	1.3737	0.2892	0.8065	1.9402	5.81
10	Laumon et al., 2005	< 1 ng/ml	1.57	0.84	2.95	0.4511	-0.1744	1.0818	0.4511	0.3205	-0.1744	1.0818	4.73
11	Laumon et al., 2005	1 - 2 ng/ml	1.54	1.1	2.18	0.4318	0.0953	0.7793	0.4318	0.1745	0.0953	0.7793	15.95
12	Laumon et al., 2005	3 - 4 ng/ml	2.13	1.22	3.73	0.7561	0.1989	1.3164	0.7561	0.2851	0.1989	1.3164	5.97
13	Laumon et al., 2005	> 5 ng/ml	2.2	1.32	3.38	0.7885	0.2776	1.2179	0.7885	0.2399	0.2776	1.2179	8.44
14	Gadegbeku et al., 2011	1 - 2 ng/ml	1.53	1.03	2.27	0.4253	0.0296	0.8198	0.4253	0.2016	0.0296	0.8198	11.95
15	Gadegbeku et al., 2011	3 - 4 ng/ml	2.84	1.4	5.6	1.0438	0.3365	1.7228	1.0438	0.3537	0.3365	1.7228	3.88
16	Gadegbeku et al., 2011	> 5 ng/ml	2.01	1.24	3.27	0.6981	0.2151	1.1848	0.6981	0.2474	0.2151	1.1848	7.94

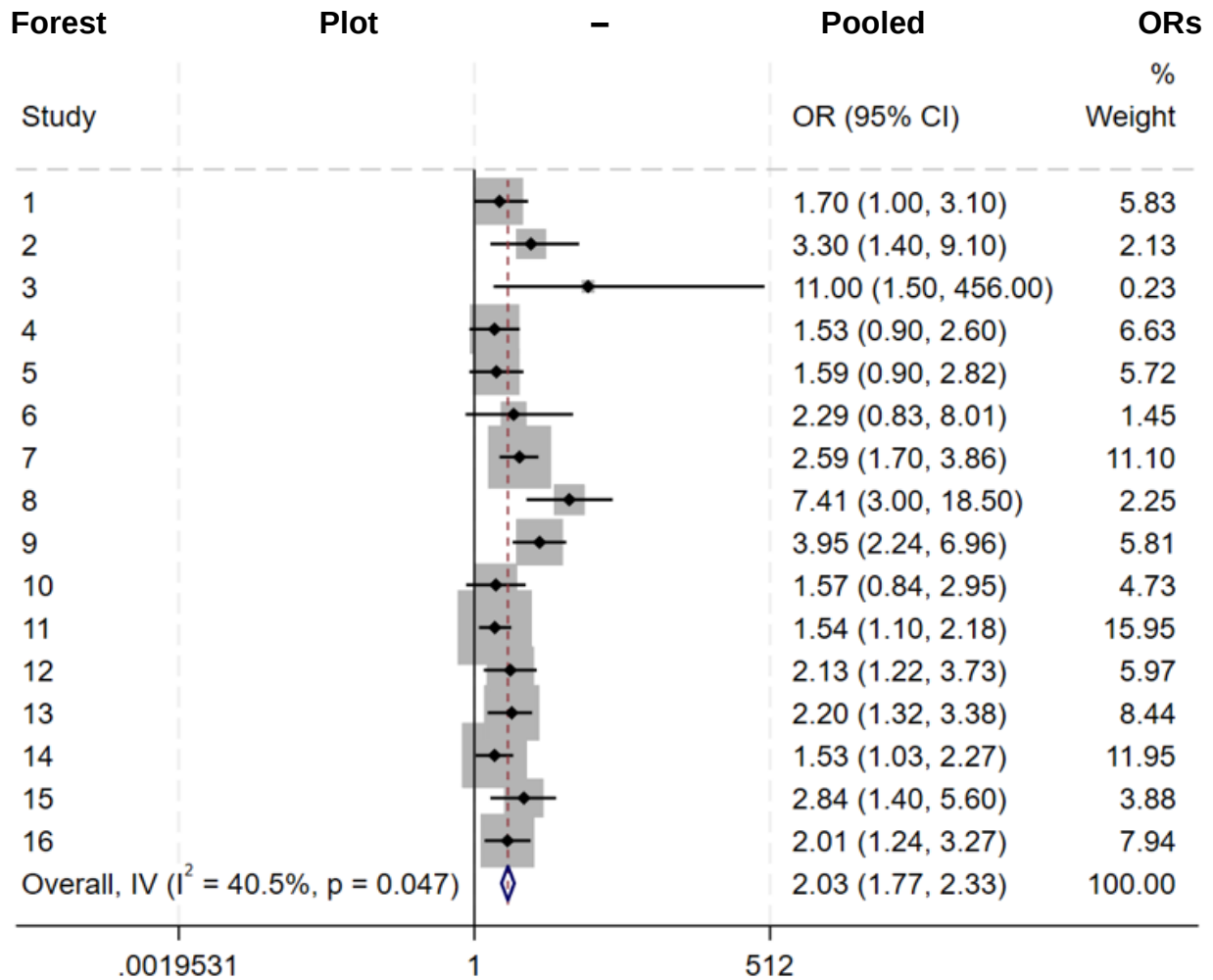


Figure 36 Forest plot of pooled ORs

Meta-analysis pooling of aggregated data

Meta-analysis pooling of aggregate data
using the common-effect inverse-variance model

Study	OR	[95% Conf. Interval]		% Weight
1	1.700	1.000	3.100	5.83
2	3.300	1.400	9.100	2.13
3	11.000	1.500	456.000	0.23
4	1.530	0.900	2.600	6.63
5	1.590	0.900	2.820	5.72
6	2.290	0.830	8.010	1.45
7	2.590	1.700	3.860	11.10
8	7.410	3.000	18.500	2.25
9	3.950	2.240	6.960	5.81
10	1.570	0.840	2.950	4.73
11	1.540	1.100	2.180	15.95
12	2.130	1.220	3.730	5.97
13	2.200	1.320	3.380	8.44
14	1.530	1.030	2.270	11.95
15	2.840	1.400	5.600	3.88
16	2.010	1.240	3.270	7.94
Overall, IV	2.029	1.770	2.326	100.00

Test of overall effect = 1: $z = 10.156$ $p = 0.000$

Heterogeneity measures, calculated from the data
with Conf. Intervals based on non-central χ^2 (common-effect) distribution for Q

Measure	Value	df	p-value
Cochran's Q	25.19	15	0.047
	-[95% Conf. Interval]-		
H	1.296	1.000	1.712
I ² (%)	40.5%	0.0%	65.9%

H = relative excess in Cochran's Q over its degrees-of-freedom

I² = proportion of total variation in effect estimate due to between-study heterogeneity (based on Q)

Figure 37 Meta-analysis pooling of aggregate data

Heterogeneity was assessed using the non-central chi-square test and was found to be significant ($I^2 = 40.5\%$). Although the effect sizes in this study were large, the decision was made not to increase the certainty in the findings up to moderate because of the large confidence intervals associated with the ORs.

The main strength of this pooled studies of ORs is that they measured THC in blood instead of urine or saliva samples as this is the most accurate biomarker for confirmation of drug presence in comparison to others (Martin et al., 2017). The common limitation across all the studies was included in the meta-analysis is that there had been a delay between the time of crash and the time blood was drawn from the subjects which could have underrated the THC dose-effect thereby influencing the ORs. However, heterogeneity favours the results of the study due to the diversity of the sampled population.

3.4.1.4 Systematic review and discussion

From this meta-analysis of ORs, it was established that the first signs of impairment are evident from THC blood levels of above 1 ng/ml, with impairment worsening mildly and progressively with each 0.5 ng/ml THC dosage upward (Brubacher et al., 2019). Dosages of higher than 2 ng/ml show moderate impairment while dosages of above 5 ng/ml show considerable impairment and significant impairment at above 10 ng/ml. It is also established that THC blood levels of less than 1 ng/ml have insignificant bearing on the ability for performance and safety, which is consistent with other studies such as Poulsen et al., (2014), Elvik, (2013), Martin et al., (2017) and Asbridge et al., (2012). The marked dose-effect suggests a causal role which essentially weakens the capacities necessary for safe driving and an increase in self-confidence that pushes drivers to overestimate their capacities particularly driving at higher or unsafe speed limits.

Consistent with the results of this meta-analysis are other studies which have confirmed cut-off blood limits of intoxication above which users are a danger to themselves and others. One such study was a Clinical Test of Impairment (CTI) study by Hjelmeland et al., (2024) in Norway conducted to investigate the relationship between blood

concentrations of THC and driver impairment using a sample of 15, 514 individual mono drug-cases collected over 9 years. The analytical cut-off value for THC in the blood was marked at 2 ng/ml. The results of that study showed that mildly impaired thresholds were visible at about 2.1 ng/ml with moderate and considerable impairment at over 2.5 ng/ml. Although the correlation between blood concentrations and THC was slightly lower compared to the other drugs, it was significant enough with a standard beta of 0.7. A limitation of the study is that it was based on a sample of accident victims only which could have biased the study towards higher concentrations. Additionally, the study does not quantify the sample into either short- or long-term cannabis usage rendering the correlation results open to interpretation.

Another such study was a scientific study conducted by Ramaekers et al., (2006) to provide a scientific framework for developing per se limits for driving under the influence of cannabis. Twenty recreational users of cannabis participated in a double-blind, placebo-controlled, three-way cross-over study. Performance tests measuring skills related to driving were conducted at regular intervals between 15min and 6h post smoking and included measures of perceptual-motor control (critical tracking task), motor impulsive (stop signal task) and cognitive function (tower of London). Blood and oral fluid were collected throughout testing.

Results of that study showed a strong and linear relation between THC in serum and oral fluid. The proportion of observations showing impairment progressively increased as a function of serum THC in every task. Binomial tests showed an initial and significant shift toward impairment in the critical tracking task for serum THC concentrations between 2 and 5 ng/ml. At concentrations between 5 and 10 ng/ml approximately 75–90% of the observations were indicative of significant impairment in every performance test. At THC concentrations of over 30 ng/ml the proportion of observations indicative of significant impairment increased to a full 100% in every performance tests. That study concluded that serum THC concentrations between 2 and 5 ng/ml establish the lower and upper range of a THC limit for intoxication. The limitation of this result is that the study was conducted only on blood serum and oral

fluid for short term use. A study on urine and for long term use might show different cutoff thresholds.

Another retrospective cross-sectional study was conducted in Spain to determine the relationship between observed signs of impairment and THC concentration in oral fluid (Fierro, González-Luque & Álvarez, 2014). This was to confirm whether a police officer's judgement regarding signs of impairment was related to the concentration of THC in oral fluid based on a sample of 2,632 cases. The observation related to signs in coordination, eyes, speech, facial expression, body appearance, attitude, and any other sign.

The results of that study showed that signs of impairment were noticeable in the eyes from a THC concentration of greater than 3.0 ng/ml in oral fluid. Over a THC concentration of 25 ng/ml, the study showed impairment in all behaviors related to facial expression and speech signs. The signs of impairment showed incremental visibility with a THC concentration of greater than 100 ng/ml. The study further showed that alcohol and THC contribute to impairment independently and, when taken simultaneously, the effects are comparable to the sum of the effects when consumed separately. This study showed a clear association between cannabis use and intoxication for different THC concentrations although indicated the limitation that oral fluid as a clinical test has low sensitivity and specificity in random surveys requiring confirmatory of blood testing.

Most of the research on cannabis pharmacokinetics has evaluated inhaled cannabis, and a few on oral "edibles", which are increasingly becoming popularly used. To assess oral cannabis pharmacokinetics and pharmacodynamics, a scientific study was conducted by Vandrey et al., (2017) on healthy adults who were administered cannabis brownies containing 10, 25 or 50 mg THC. Whole blood and oral fluid specimens were obtained at baseline and then for 9 days post-exposure at 6 days in residential research setting and 3 days as outpatients. Measures of subjective, cardiovascular and performance effects were obtained at baseline and for 8 h post-ingestion. The mean

Cmax for THC in whole blood was 1, 3.5 and 3.3 ng/mL for the 10, 25 and 50 mg THC doses, respectively.

The Cmax blood concentrations of THC metabolites were generally higher than THC and had longer Tmax values. The mean Tmax for THC in oral fluid occurred immediately following oral dose administration and appear to reflect local topical residue rather than systemic bioavailability. Mean Cmax oral fluid concentrations of the THC metabolite were lower than THC, erratic over time and mean Tmax occurred at longer times than THC. The window of THC detection ranged from 0 to 22 hours for whole blood at 0.5 ng/mL and from 1.9 to 22 hours for oral fluid at 1.0 ng/ml.

This study established that subjective drug and cognitive performance effects were generally dose dependent, peaking at 1.5–3 hours post-administration, and lasting 6–8 hours. Whole blood cannabinoid concentrations were significantly correlated with subjective drug effects. The correlations between blood cannabinoids and cognitive performance measures, and between oral fluid and all pharmacodynamic outcomes were either non-significant or not orderly by dose. The study further established that quantitative levels of cannabinoids in whole blood and oral fluid were low compared with levels observed following inhalation of cannabis in other studies emphasizing the importance of the route of administration for interpretation of cannabinoid toxicology.

An investigative study into the effects of polysubstance use including THC was conducted by Gierde et al., (2023) on blood samples submitted for forensic toxicology testing from drug driving suspects in Norway between 2013 and 2020. This investigation aimed to study the extent of polysubstance use among apprehended crash-involved drivers with THC concentrations above the legal limit and explore the importance of THC in polysubstance cases. This study found that over 20% of the 10,520 apprehended crash-involved drivers had concentrations of THC in their blood above the legal limit of 1.3 ng/mL, and 84% of those also had concentrations of alcohol or other drugs above the legal limits such as 61% for sedatives, 38% for stimulants, 33% for alcohol, and 10% for opioids.

The proportion of drivers with THC of greater than 5 ng/ mL was highest if the blood sample was collected within 90 min after the crash, and when only THC was detected. There was a statistically significant inverse association between THC concentrations greater than 5 ng/mL and levels of alcohol or amphetamines at the highest sanction level. That study established that most apprehended crash-involved THC-positive drivers also tested positive for other psychoactive substances and that drivers with high blood THC concentrations had less often high concentrations of other substances implying that cannabis might then have been a more important contributor to impairment.

In a systematic review of the correlation between oral fluid and whole blood THC concentration conducted by Robertson et al., (2022), a meta-analysis was conducted to identify all research that compared oral fluid with whole blood THC levels in impaired drivers. Individual-level data was obtained from study authors and pooled to calculate sensitivity and specificity of oral fluid THC (at various cut-off values) to detect toxicity of whole blood THC above different concentration limits and to explore practical implications of using oral fluid THC in an enforcement context. That study confirmed the association of THC and impairment based on the cut-off values in each study.

The study also found a strong correlation between the presence of THC in oral fluid and presence of THC in whole blood at a sensitivity of 71.2% and specificity of 97.7%, although the cut-off values were found to be less sensitive and specific when used as a biomarker to detect people with whole blood THC concentrations above commonly used per se limits such as 5 ng/ml. The overall result showed that oral fluid does not normally have a one-to-one concentration ratio with whole blood, all held constant, although the presence of the former can provide a good indication of the presence of the latter (Jin et al., 2018; Van der Linden et al., 2012). The following were some of the cut-off values of impairment included in the meta-analysis:

- a) A study by Bakke et al., (2019) to detect drugs in simultaneously collected samples of drivers suspected of intoxication tested oral fluid and whole blood samples for THC using cut-off values of 0.9 ng/ml oral fluid and 0.6 ng/ml whole blood. This study found a sensitivity of 50.1% and specificity of 95.8%, which

also determined that detection time was shorter in oral fluid compared to whole blood given the recovery of valid samples between the two.

- b) A study by Europe's Roadside Testing Assessment (ROSITA) was conducted to compare results from on-site performance tests with laboratory confirmation results of oral fluid and whole blood collected samples from drugged drivers (Pehrsson et al., 2008). The cut-off values for intoxication used were 2 ng/ml oral fluid and 1 ng/ml whole blood which yielded correlation showing a sensitivity of 68.3% and specificity of 88.0%.
- c) Driving Under the Influence of Drugs (DRUID) study to detect illicit drugs in oral fluid as a biomarker for drugs in whole blood was reported by Gjerde et al., (2015). This study aimed to determine whether the analysis of oral fluid could be used to identify individual drivers with drug concentrations in whole blood above 25 ng/ml. The study used the original cut-off values of 1.0 ng/ml for both oral fluid and whole blood as determined by the European Druid Project. This study found that 65% more THC concentration in oral fluid was required to detect an equivalent of THC in whole blood presenting a sensitivity of 76.9% and specificity of 97.1%.

Paolo et al., (2018) conducted a meta-analysis of the epidemiological studies that had been conducted on the correlation between blood and oral fluid drug concentrations and cognitive impairment in drivers who had been driving under the influence of drugs including THC. The relevant scientific articles included in this review were sourced from PubMed, Cochrane Central, Scopus, Web of Science and Science Direct. The analysis of THC on oral fluid showed a correlation of between 1.7 to 3 ng/ml with signs of impaired attitude, body appearance, facial expression, speech coordination and eye signs. They report that although epidemiological studies suggest that THC blood concentrations of up to 5 ng/ml are generally associated with driving impairment and increased accident risk, a significant correlation is still not clear due to the complex pharmacokinetics and metabolism of THC and the variability in blood concentrations of consumers of similar doses.

Battistella et al., (2013) conducted a scientific toxicology investigation to evaluate the impact of cannabis on the driving ability of occasional smokers by examining changes in the brain network involved in a tracking task. Thirty-one male volunteers were enrolled in this study that included clinical and toxicological aspects together with functional magnetic resonance imaging of the brain and measurements of psychomotor skills. The fMRI paradigm was based on a visuo-motor tracking task, alternating active tracking blocks with passive tracking viewing and rest condition. Consistent with their hypothesis and the validated results, the researchers found that THC exposure significantly decreases task performance from a cut-off value of 2.9 ng/ml onwards with the effects of cannabis on brain functions and behaviour extending widely beyond the distribution phase of THC. Although the study did not show correlation between cannabis measurements and performance and blood oxygen level dependency, it showed that smoking cannabis significantly decreases psychomotor skills and globally alters the activity of the main brain networks involved in cognition even at low concentrations of THC in the blood.

Limited data are available for interpreting THC concentrations after chronic cannabis exposure mainly because of ethical and safety concerns limiting administration of chronic smoked doses and the high cost and difficulty of continuous monitoring, collection, and analysis of specimens during extended cannabinoid excretion.

However, one of the first studies on the effects of chronic cannabis use on impairment was reported by Karschner et al., (2009) in Maryland USA on 18 long term heavy cannabis smokers recruited in the National Institute on Drug Abuse research unit for seven days of monitored abstinence. That study found that a median of 1.9 ng/mL at day 1 and 1.1 ng/mL at day 7 of THC in plasma was found on the participants with the range of concentrations between 0.5 and 9.0 ng/ml throughout the period. The study concluded that although plasma THC concentration greater than 2 ng/ml were observed in multiple specimens after seven days of cannabis abstinence, it is not because of recent usage but suggests a mechanism for residual neurocognitive impairment which may not be as acute as regular users.

Another review study that attempted to compare concentration of THC in occasional and chronic users as well as the effects of the route of administration was documented by Sharma, Murthy & Bharath, (2012). The study showed that most of the THC in the blood is found in the plasma and the rest in the red blood cells. THC concentration was detectable in plasma approximately 8 minutes after onset of smoking leading to a shift in psychological and behavioural effects from a concentration of about 1 to 4 ng/ml. The level of the peak reached in plasma depends on individual behaviors such as the length of inhalation, the breath-holding and the depth of inhalation in the lungs. The amount of THC in the plasma is approximately 23-27% in heavy users and about 10-14% for occasional users.

In comparison to smoking and inhalation, after oral ingestion, systemic absorption is relatively slow resulting in maximum THC plasma concentration within 1-2 hours which could be delayed by few hours in certain cases. After oral administration, maximum THC plasma concentration was observed at 2.7-6.3 ng/mL for a 15 mg dosage showing considerable impairment. THC concentration in urine samples was much higher at a minimum of 3.2 ng/ml for the same dosage within two hours. It was concluded that significantly higher concentration of THC was produced after ingestion than inhalation.

In a forensic science study by Agius et al., (2012), conducted to review the cut-off limits for drugs of abuse following the introduction of new German driving license re-granting guidelines for driver fitness, new evidence emerged regarding the sensitivity and specificity of the previous measurements. Over 3500 samples were tested under the old medical and psychological assessment guidelines which had set 50 ng/ml as a cut-off for urine screening, indicating driver unfitness. That study showed that reducing the urine screening cut-off value to 10 ng/ml and a limit of detection to 2.5 ng/ml in confirmation data not only increased the sensitivity and specificity but also extended the detection time of THC for occasional users by around 10 to 26 days and over a month for chronic users.

There are other studies which showed higher cut-off limits for impairment due to cannabis. One such study was a clinical trial by Hartman et al., (2015) which sought

to determine how blood THC concentrations relate to driving impairment with or without alcohol. The participants were administered with low dose alcohol and inhaled 500mg placebo cannabis and went through advanced driving simulation. The study established that significant impairment was observable with standard deviation lateral control at a concentration of 8.2 ng/ml of THC without alcohol and 5 ng/ml with alcohol. Another report was published by Grotenhermen et al., (2007) after evaluating evidence from experimental and epidemiological research on the approaches to develop per se limits for cannabis.

A comparison of the meta-analysis suggested that a THC concentration in the serum of 7–10 ng/ml was correlated with an impairment comparable to that caused by a BAC of 0.05%, indicating that a suitable numerical limit for THC in serum may fall in that range. Another prospective case-control study was conducted by Jeffrey et al., (2019) to determine whether drivers injured in motor vehicle collisions who tested positive for THC were likely to contribute to the crashes than those who had tested negative. The unconditional logistic regression results showed that there was no risk of crash responsibility in drivers with less than 5 ng/ml of THC in whole blood. However, a non-significant increased risk of crash responsibility showed a higher odds ratio for THC of greater than 5 ng/ml in whole blood.

There are other strong empirical data on THC blood concentrations in relation to driving performance. For instance, several studies, in different countries (Sweden N = 1,276; Norway, N = 589; Switzerland N = 440), have been conducted in apprehended drug drivers with THC as the only psychoactive compound in blood. Median concentrations of THC detected in blood in apprehended drug-drivers across 3 different countries were remarkably similar at 2 ng/ml (range 0.3 ng/ml to 67 ng/ml); 2.2 ng/ml (range 0.3 ng/ml to 45 ng/ml) and 3 ng/ml, respectively (Jones et al, 2008; Augsburger et al, 2005; Kronstrand & Jones, 2000).

A further meta-analysis of 21 studies investigating cannabis ingestion and driving performance revealed that a blood concentration of 3.7 ng/ml THC (3.1 ng/ml to 4.5 ng/ml) impairs drivers to a concentration equivalent to a BAC of 50mg/100 ml

(Berghaus et al, 2010). Another meta-analysis of 78 studies investigating smoking cannabis revealed a serum concentration of 3.8 ng/ml (2 ng/ml whole blood) THC (range 3.3 ng/ml to 4.5 ng/ml) impairing drivers to a concentration equivalent to BAC of 0.5mg/100 ml for smoked administration (DRUID D1.1.2b).

A summary of the cut-off limits reviewed in the literature is presented in **Table 12**.

Table 12 Summary of THC cut-off limits

#	Authors	Study type	Sample type	Route of administration	Cut-off limits
1	Hjelmeland et al., (2024)	Clinical trial	Whole blood	Unspecified	2.1 - 2.5 ng/ml
2	Ramaekers et al., (2006)	Scientific review	Serum	Inhalation	2 - 5 ng/ml
3	Fierro, González-Luque & Álvarez, 2014	Retrospective cross-sectional	Oral fluid	Unspecified	> 3 ng/ml
4	Vandrey et al., (2017)	Scientific review	Whole blood	Ingestion (Brownies)	0.5 ng/ml
	Vandrey et al., (2017)	Scientific review	Oral fluid	Ingestion (Brownies)	1.9 ng/ml
5	Gierde et al., (2023)	Scientific review	Whole blood	Unspecified	1.3 ng/ml
6	Bakke et al., (2019)	Scientific (Meta-Analysis)	Oral fluid	Unspecified	0.9 ng/ml
	Bakke et al., (2019)	Scientific (Meta-Analysis)	Whole blood	Unspecified	0.6 ng/ml
7	Pehrsson et al., 2008	Scientific (Meta-Analysis)	Oral fluid	Unspecified	2 ng/ml
	Pehrsson et al., 2008	Scientific (Meta-Analysis)	Whole blood	Unspecified	1 ng/ml
8	Gjerde et al., (2015)	Scientific (Meta-Analysis)	Oral fluid	Unspecified	1 ng/ml
	Gjerde et al., (2015)	Scientific (Meta-Analysis)	Whole blood	Unspecified	1 ng/ml
9	Paolo et al., (2018)	Epidemiological Review	Oral fluid	Unspecified	1.7 – 3 ng/ml
10	Battistella et al., (2013)	Scientific Toxicology Review	Oral fluid	Inhalation	2.9 ng/ml
	Battistella et al., (2013)	Scientific Toxicology Review	Whole blood	Inhalation	2.9 ng/ml
	Battistella et al., (2013)	Scientific Toxicology Review	Urine	Inhalation	2.9 ng/ml
11	Karschner et al., (2009)	Scientific review	Plasma	Inhalation	2 ng/ml
12	Sharma, Murthy & Bharath, (2012)	Scientific review	Plasma	Inhalation	1.4 ng/ml
	Sharma, Murthy & Bharath, (2012)	Scientific review	Plasma	Ingestion	2.7 ng/ml
	Sharma, Murthy & Bharath, (2012)	Scientific review	Urine	Ingestion	3.2 ng/ml
13	Agius et al., (2012)	Forensic Science Review	Urine - Screening	Unspecified	10 ng/ml
	Agius et al., (2012)	Forensic Science Review	Urine	Unspecified	2.5 ng/ml
14	Jeffrey et al., (2019)	Prospective case-control study	Whole blood	Unspecified	5 ng/ml
15	Grotenhermen et al., (2007)	Experimental epidemiological & (Meta-Analysis)	Whole blood	Inhalation	7 - 10 ng/ml
16	Hartman et al., (2015)	Clinical trial	Whole blood	Inhalation	8.2 ng/ml
17	Jones et al, 2008	Empirical Science	Whole blood	Unspecified	2 ng/ml

18	Augsburger et al, 2005	Empirical Science	Whole blood	Unspecified	2.2 ng/ml
19	Kronstrand & Jones, 2000	Empirical Science	Whole blood	Unspecified	3 ng/ml
20	Berghaus et al, 2010	Meta-Analysis	Whole blood	Unspecified	3.7 ng/ml
21	DRUID D1.1.2b	Meta-Analysis	Serum	Inhalation	3.8 ng/ml
	DRUID D1.1.2b	Meta-Analysis	Whole blood	Inhalation	2 ng/ml

3.4.1.5 International per se limits for cannabis

To control accidents while driving under the influence of drugs many countries have made it a criminal offence for an individual to have a specified amount of drug or metabolite in his or her body while operating a motor vehicle. This threshold concentration is a legal limit or per se limit, and exceeding this amount serves as proof of legal impairment (Wong, Brady & Li, 2014). These limits have been proposed for workplace safety promotion.

In 2015 the Substance Abuse and Mental Health Services Administration (SAMHSA) in the USA published that cannabis testing in oral fluid was accepted and the target analyte being active THC with a proposed initial screen cut-off of 4 ng/ml and confirmation cut-off of 2 ng/ml (Kulig, 2017) and was adopted in several federal governments. In Canada, per se thresholds of 5 ng/ml Δ^9 THC when measured in blood and 25 ng/ml when measured in saliva have been adopted (Di Ciano et al., 2023). **Table 13** below shows the legal Δ^9 THC thresholds for drivers in individual states in the USA with per se laws.

Table 13 USA per se THC laws

State	Legal THC limit	Collected specimen
Colorado	5 ng/ml in blood	Blood, urine, or OF
Illinois	5 ng/ml in blood	Blood
Montana	5 ng/ml in blood	Blood
Washington	5 ng/ml in blood	Blood
Pennsylvania	1 ng/ml in blood or urine	Blood or urine
Nevada	2 ng/ml	Blood
Ohio	2 ng/ml in blood, serum, plasma 10 ng/ml in urine	Blood, urine, or other bodily substance

Sources: Lacey et al., 2010; Avila, 2011; Walsh, 2009; Norml, 2014.

European countries adopted a two-tiered approach to THC legislation consisting of impairment testing and per se limit system.

Table 14 below shows the types of drugged driving legislation and legal Δ 9-THC thresholds for drivers in European countries.

Table 14 Europe per se THC laws

Country	Legislation	Legal THC limit in laboratory tests
Belgium	Two-tier (Analytical cut-off)	1 ng/ml in blood plasma 10 ng/ml in oral fluid
Czech Republic	Per se	1 ng/ml in blood serum
Denmark	Two-tier (Analytical cut-off)	1 ng/ml in blood
Finland	Two-tier (Analytical cut-off)	1 ng/ml in blood
		5 ng/ml in blood
France	Two-tier (Analytical cut-off)	0.5 ng/ml in blood 1 ng/ml in oral fluid
Germany	Two-tier (Analytical cut-off)	1 ng/ml in blood serum
Greece	Impairment	1 ng/ml in blood
Ireland	Impairment	2 ng/ml in blood
		5 ng/ml in blood serum
Italy	Per se	0.5 ng/ml in blood
Luxembourg	Impairment	2 ng/ml in blood serum
Netherlands	Impairment	3 ng/ml in blood
		5 ng/ml in blood serum
Norway	Impairment	1.3 ng/ml in blood
Poland	Per se	2 ng/ml in blood
Portugal	Per se	3 ng/ml in blood
Slovenia	Per se	0.3 ng/ml in blood serum
Sweden	Zero tolerance	0.3 ng/ml in blood
Switzerland	Per se	1.5 ng/ml in blood
United Kingdom	Impairment	2 ng/ml in blood

Sources: Verstraete et al., 2011; Wolff & Johnston, 2014

Additionally, Norway specified THC levels comparable to BAC regarding the severity of impairment as 3 ng/ml in blood is comparable to 0.05% BAC; 9 ng/ml in blood is comparable to 0.12% BAC. In the United Kingdom, initial drug screening is conducted using drugalyser oral swab tests. A positive test could lead to a blood sample test to quantify THC level.

Due to the limitations of impairment-based and zero tolerance laws, governments are increasingly adopting per se limits at which a driver is legally defined as being impaired and unfit to safely operate a motor vehicle. Some countries in Europe have also adopted a two-tier system, which incorporates both impairment-based and per se approaches (Wong, Brady & Li, 2014).

Denmark regulates the limit of THC in the blood in relation to driving. Low level use is above 1 ng/ml in blood and concerns non-prescribed THC or THC that is not consumed according to the prescription. In 2017 the law was changed to introduce a progressive sanctioning scale. Driving under the influence of THC with a maximum limit of 3 ng/ml in blood is punishable by a fine. The sanctions system is based on different levels of THC found in the blood according to the following **Table 15** as illustrated below.

Table 15 Fining THC blood levels in Denmark

Offense number	Driving with low THC level above 1 ng/ml but not over 3 ng/ml in blood	Driving with medium THC level above 3 ng/ml but not above 9 ng/ml THC in blood	Driving with high THC level above 9 ng/ml THC in blood
1st time	Fine (1/2 month net pay)	Fine (1 month net pay)	Fine (1 month net pay)
2 nd time	Fine (1/2 month net pay)	10 days prison	10 days prison
3 rd time	Fine (1/2 month net pay)	20 days prison	20 days prison
4 th time	Fine (1/2 month net pay)	30 days prison	30 days prison
5 th time	Fine (1/2 month net pay)	40 days prison	40 days prison
6 th time	Fine (1/2 month net pay)	50 days Prison	50 days Prison

Source: Egnell, Villman & Obstbaum, 2019

South Africa recently implemented per se limits for driving under the influence of THC as part of the NRTA.

In South Africa, the CPP was passed early in 2024 permitting personal, private production and use of cannabis within regulated limits. Along with this bill, updates were made to the NRTA, establishing cut-off limits for THC in the bloodstream. It also provides prohibitions around activities such as “Driving or occupying driver’s seat while under the influence of intoxicating liquor or, a drug having a narcotic effect or THC, or with an excessive amount of alcohol or THC or a drug having a narcotic effect in blood or breath”.

The cut-off limit for THC use in South Africa is 2 ng/ml blood concentration for any person and 1 ng/ml for professional drivers, and it precludes persons from driving or sitting in the driver’s seat of a running vehicle (Parliament, 2020). The updates specify that the sample must be collected within two hours of an incident. The updates to the act do not include urine tests or saliva tests or provide limits for urine or saliva or metabolites of THC.

3.4.1.6 Proposed allowable limits for cannabis use in the SAMI

The results of the meta-analysis of ORs conducted in this study show that THC blood levels of less than 1 ng/ml are insignificant and do not pose a safety risk to the health and safety of individuals and others (Laumon et al., 2005). This was corroborated by findings from several other studies that demonstrated the insignificance of THC blood dosage of less than 1 ng/ml on performance and safety Poulsen et al., (2014), Elvik, (2013), Martin et al., (2017) and Asbridge et al., (2012). A few studies that referenced THC blood limits of less than 1 ng/ml were based on oral fluids indicative of recent use although toxicology could not be established at that dosage (Bakke et al., 2019; Vandrey et al., 2017). Likewise, the countries that have implemented per se limits of less than 1 ng/ml such as Slovenia and Sweden with a limit of 0.3 ng/ml have done so mostly as a deterrent measure, with safety considerations as a secondary factor. (Verstraete et al., 2011; Wolff & Johnston, 2014).

However, the results of the meta-analysis have shown that THC blood levels of 1 ng/ml and above have a dose-effect causal role which weakens the capacities thereby posing a potential health and safety risk to cannabis users and others (Laumon et al., (2005) and Gadegbeku et al., (2011). At THC blood levels of 1 ng/ml, impairment is mild and

progresses with additional dosage such that it is considerably impaired at THC blood levels of 2 ng/ml and above. This was substantiated by other studies from the systematic review conducted in this study, showing the potential negative impact of THC blood levels greater than 1 ng/ml and greater than 2 ng/ml on health and safety (Hjelmeland et al., 2024; Ramaekers et al., 2006).

The negative impact of elevated levels of THC was further confirmed in studies on oral fluid by Pehrsson et al., (2008), Vandrey et al., (2017) and Bakke et al., (2019) showing impairment from 2 ng/ml. Levels of 2.5 ng/ml THC in urine were confirmed to cause impairment by Agius et al., (2012) and Sharma, Murthy & Bharath, (2012). Further confirmation was made from studies of polysubstance use and chronic users by Gierde et al., (2023) and Karschner et al., (2009) respectively, showing THC levels of 1.3 ng/ml in the former study and 2 ng/ml in the latter.

Based on the empirical evidence showing impairment from THC blood levels of 1 ng/ml and above, several countries have marked their per se limits at or above this threshold. For example, the SAMHSA in the USA marked confirmation cut-off levels of THC at 2 ng/ml (Kulig, 2017), while Pennsylvania marked theirs at 1 ng/ml and Ohio at 2 ng/ml for both blood and urine samples (Lacey et al., 2010; Avila, 2011; Walsh, 2009; Norml, 2014). Similarly, the European countries have set cut-offs of 1.3 ng/ml in Norway, 1.5 ng/ml in Switzerland and 2 ng/ml in Poland, UK and Luxembourg (Verstraete et al., 2011; Wolff & Johnston, 2014). Denmark has even implemented a tiered approach to fine offenders with THC levels from 1 ng/ml and above (Egnell, Villman & Obstbaum, 2019). The recent amendment to the NRTA in South Africa to restrict cannabis use at THC cut-off levels of 2 ng/ml for the public and 1 ng/ml for professional drivers is further acknowledgement of the negative impact of cannabis at these cut-offs.

Based on the evidence from the systematic review and meta-analysis of ORs in this study and given the per se limits for cannabis use that have been implemented globally, it is recommended that the SAMI implements the following maximum allowable blood limits of cannabis use:

- iii. **1 ng/ml** blood THC concentration for any employee who works in dangerous environments or involved in handling of machinery, equipment vehicles and any movable objects as part of their daily duties while in the workplace.
- iv. **2 ng/ml** blood THC concentration for any employee who is office bound and their daily duties do not involve handling of any machinery, equipment vehicles and any movable objects in the workplace.

These recommended cut-off limits are based on empirical evidence associating cannabis use with impairment and are defensible in a court of law in the same manner that the thresholds for alcohol and cannabis consumption are now legislated in South Africa.

Conclusions from Milestone 4

The systematic review of the available literature on the thresholds for cannabis use that poses health and safety risk was conducted along with a meta-analysis of ORs to pool the odds associating THC usage with impairment at different doses provided a clear indication of the cannabis thresholds for purposes of occupational health and safety.

The per se limits implemented globally were also reviewed resulting in a recommendation of the maximum allowable blood limits of cannabis that will not pose a safety risk to the health and safety of individuals and other employees in the SAMI. Legal certainty was also established regarding when cannabis users would pose a health and safety risk if they exceed the maximum allowable blood levels of THC in their system. Overall, the methods utilised for this milestone yielded the intended results.

3.5 MILESTONE 5

Results and Outcomes for Milestone 5

The aim of milestone 5 was to conduct a workshop with the industry stakeholders to discuss the findings of the research study and to solicit their input. The workshop was held at the Protea Hotel in Midrand, South Africa.

A total number of three hundred and two (N=302) potential attendees had responded to the invitation, of which eighty-two (n=82) expressed that they would attend in person and two hundred and twenty (n=220) virtually. The actual workshop was conducted on 19 July 2024 as planned, from 08h30 to 15h00 South African Standard Time (SAST). On that day, fifty-five (n=55) participants attended in person, and two hundred and twenty-two (n=222) attended the workshop virtually representing an overall workshop attendance rate of 74%.

All the strategic partners listed above were represented, including a wide range of professionals such as occupational medical practitioners, occupational hygienists, medical doctors, toxicologists, occupational health and safety specialists, safety officers, human resource specialists, environmental specialists, legal experts, business partners, business administrators, and other designations. There was no notable gap in the representation of both organisations and professionals. Full lists of virtual and in-person attendees are attached as **Appendix 8.6 and 8.7** respectively.

3.5.1.1 Workshop agenda

The agenda for the workshop is attached to this document as **Appendix 8.12** and was facilitated by subject matter experts and management consultants from the MHSC and MBC respectively. The approach used throughout the workshop was high impact interactivity for both virtual and in person participants to ensure that the content of the output would largely be shaped by the participants' discussions and contributions. Substantial attention was focused on ensuring that ample time was provisioned for comprehensive interactive engagement and in-depth discussion of the issues at hand.

The sequence of events was structured in such a way that the first agenda items were presentations by the MHSC on the health and safety statistics in the SAMI and a moment of silence for the departed and workers harmed while on duty in the industry.

Second on the agenda list was an overview of the cannabis project in the SAMI presented by the MBC team. The actual presentation is attached to this document as **Appendix 8.13**. The participants were taken through the literature review findings showing the prevalence of cannabis as one of the most abused and illegally trafficked

drugs leading to its regulation locally and most jurisdictions globally. It was shown that cannabis is a plant with over 300 chemical compounds and can be used for purposes such as medicinal, alimentary and industry. The most popular usage is for recreational purposes due to its psychoactive properties. Hence, the focus of the presentation was on the psychological effects of cannabis showing that it is an addictive drug which potentially affects the central nervous system and alters the state of consciousness in the short-term and causes psychosis and poor performance in the long-term. With regards to its impact in the workplace, it was shown that cannabis abuse can negatively impact the ability to perform duties such as decision making, multi-tasking, taking, or giving instructions, routine tasks and operating machinery or motor vehicles.

This presentation also showed the tools and methods available for detecting and screening for smoked or ingested cannabis which included invasive, semi-invasive and non-invasive tools comprising of biomarkers such as urine, saliva, hair, sweat (for screening and detection) and blood (for confirmation test). It was established that the traditional methods of screening and testing for cannabis in the workplace are no longer effective and reliable as was shown in a few recent court cases that were presented for arbitration and relief in South Africa. Employees had challenged the dismissal from employment after testing positive for cannabis even if they were able to perform the required duties and had consumed cannabis in their own private spaces.

The conclusion of that presentation was that there was a need for clear policies on cannabis management in the workplace that can be argued successfully before a court of law. These policies should include a revision to the tools and methods used for screening, detecting, and testing for cannabis. It was further concluded that while employers have the right to set standards of operation in their establishments which employees should adhere to, intoxication in the workplace still needs to be proven and employees should be treated fairly.

Third on the agenda list was the presentation of the survey feedback on the SAMI stakeholder engagements that had been conducted by MBC between March 2024 and April 2024. The actual presentation is attached to this document as **Appendix 8.14**.

The survey had been conducted to gauge perspectives of the SAMI stakeholders on health and safety at the mining operations after cannabis for private use was decriminalised in 2018. It was shown that most stakeholders in the SAMI were aware of the decriminalisation of cannabis and that they perceived cannabis to have a negative impact on occupational health and safety in the workplace. Most of the stakeholders had also indicated that they had recognized this negative impact and their attitude was that something needed to be done about it. However, the somewhat high numbers of stakeholders who did not know what their organisation's attitude towards health and safety, suggested lack of employee engagement regarding cannabis use.

The impact of cannabis decriminalisation on accidents and incidents was not clear for most stakeholders who indicated that the statistics had remained the same, while others were unsure if there had been a change. This could be attributable to the recent decriminalisation of cannabis globally and the limited case research linking accidents and incidents to cannabis use in the mining industry. Similarly, most stakeholders had indicated that there was not enough cannabis awareness and training in their organisations. On the contrary, it was shown that most stakeholders were aware of the existing drug policies and assessment procedures in their workplace and that there was no need to revise them. Regarding the drug assessment tools and testing procedures, most stakeholders were aware of their existence, although they had mixed views on their effectiveness and whether they should be revised.

For the change in employment policies, it was clear from the representation of most stakeholders that this had not be done since cannabis was decriminalised. However, there was uncertainty about whether employment policies should be revised to accommodate cannabis as shown in large representations of stakeholders who agreed, as well as those who either disagreed or were unsure. The presentation concluded by echoing the policy uncertainty around cannabis management in the SAMI as deduced in the engagements with stakeholders suggesting the need for more guidance.

Fourth on the agenda list was the presentation on the allowable blood limits for cannabis use in the SAMI workplace presented by the MBC team. The actual

presentation is attached to this document as **Appendix 8.15**. In this presentation, the focus was on the ability of cannabis to impair the ability to perform the expected duties and to show limits for such impairment. It was shown that the chemical composition of cannabis was different from other drugs in that the former has properties that bind to the fatty acids in the body such that its effects persist much longer than the other drugs, after which impairment is unlikely. Consequently, the existing methods of assessing and testing drugs make it more challenging for cannabis.

A few considerations were brought forward for further deliberation on the management of cannabis in the workplace. The first consideration was that employers should clarify what they are tested, between testing for any cannabis use or recent use, testing for zero tolerance, or testing for impairment? The second consideration was for employers to consider the use of synthetic cannabis, which is currently not detectable in normal tests, or even drug test cheating which is on the rise in most industries. The third consideration was the issue of drug combinations and simultaneous use of medication drugs which could show up in the cannabis test results even if the subjects are not intoxicated. These considerations interrogated the timing, frequency and methods that should be used for screening and testing the presence of cannabis pointing out its complex half-life. It was shown that clarifying these considerations was pertinent as it would enable the implementation of correct methods of screening and testing for the cannabis metabolites which contain psychoactive compounds rather than the parent compound.

This presentation revealed that factors that can affect the detection of cannabis levels and the length of impairment depend on the test sensitivity, the cannabis dosage and method of consumption, hydration, metabolism, body mass/fat, frequency of use and tolerance. It was further revealed that saliva presented the shortest window of detection after breath, followed by blood, urine and hair for which cannabis is detectable over 120 days. The most common biomarkers for cannabis use and intoxication are found in urine and blood although saliva is gaining popularity due to ease of use and non-invasiveness. It was presented that per se limits of between 0.5 ng/ml 5 ng/ml have been implemented as cut-off values for cannabis testing internationally. Others

have adopted a zero-tolerance policy for cannabis making it a criminal offence for being found positive.

It was concluded in this presentation that the SAMI should re-assess the overall drug policies to revise the drug screening processes towards an effect-based method which uses impairment or intoxication as a baseline comparison for further management of cannabis in the workplace. It was reiterated one more time that the existing drug assessment methods are not entirely effective to cover all causes of impairment. The options available to the SAMI for cannabis management were presented as the revision of the existing employment policies, assessment tools and methods and the revision of the code of practice to include allowable limits as well as to embrace the latest available technologies for real-time impairment monitoring. It was further presented that impairment testing should be conducted in real-time at pre-shifts, after weekends and post incidents followed by confirmatory tests for positive cannabis outcomes as well as employee support thereafter.

The rest of the agenda was filled with interactive discussions between each presentation and one short comfort break. It must be noted that there was a slight change to the original schedule where it was initially planned to break for lunch followed by further interactive discussions and workshop closure. Instead, the lunch break was preceded by the interactive discussions and the workshop closure.

3.5.1.2 Workshop discussions

As indicated above, the nature of the workshop was interactive, and participants debated and discussed a variety of issues related to the subject at hand. One of the points for discussion was the issue of cannabis testing tools, processes, and procedures as it was not clear whether the current practices were effective for cannabis or not. It was discussed and clarified that drug testing in the mining industry is primarily conducted during medical surveillances, for employee onboarding, from leave breaks, annually, post incidents, randomly, when suspected and on exit. The selection for testing is mandatory for initial and exit tests, but risk-based or random for routine testing

and is conducted as often as possible depending on job type. This should not be discontinued going forward.

It was agreed amongst participants that impairment testing is currently conducted by identifying employees who may be or appear to be intoxicated. This is done by observing employees acting out of character or losing coordination or by the smell of breath or blurry eyes. This practice is also valid and should be continued. Although there were different views about the most used tools for drug testing currently in the SAMI, several participants indicated that urine and blood tests are commonly used during mandatory medical surveillances and that pre-shift screening includes only breathalyzer tests for alcohol and smell of breath and suspected behaviour for all other drugs. It appeared that saliva is not as widely used in the SAMI as the case is in other industries, which concurred with the literature findings presented earlier.

The discussion on the legal limits that should be adopted in the SAMI was that although the South African government had recently issued the legal blood limits of 1 ng/ml and 2 ng/ml for the driver and passenger, respectively through the NRTA, the applicable limits for the SAMI should be based on the scientific limits of impairment due to cannabis for the different biomarkers identified earlier. These limits should then be incorporated in the employment contract and codes of practice, allowing all employees the opportunity to comply or exit employment if they do not agree. It was commonly agreed that cannabis should be handled in the same manner as other drugs and alcohol although additional procedures should be implemented for cannabis. Employees who test positive for cannabis should not be allowed in the workplace until such a time that they are cleared otherwise because such employees are hazards to themselves, others, and the environment.

The discussion on impairment testing revealed some confusion as to what the available options are, going forward and whether the traditional testing methods such as urine, blood and saliva should be discarded. It was clarified that impairment testing is already being conducted during pre-shift screening. Those identified as potentially impaired are then subjected to urine, saliva, and blood tests for confirmation of drug presence. This

practice is valid and should not be discontinued. The contention was that there are many digital options that are now available on the market for impairment testing in real-time which the SAMI could leverage, and compliment these with the traditional confirmatory tests. However, there was the issue of the validity and subjectivity of impairment testing as its legitimacy could be challenged in a court of law. It was concluded that more research is required into the concept of impairment testing before it can be fully embraced.

The other topic for discussion was about the reasoning behind why the South African government through the NRTA, authorized cannabis for private use and why cannabis was receiving so much attention and yet it is a drug like any other which should not be allowed in the workplace. The consensus was that government had been compelled to decriminalise cannabis to uphold human rights of freedom to do what anyone wants to do in their private space. It was noted that cannabis was part of religious ceremonies for some, medicinal in some instances and recreational for others, all of which deserve the right of use in private spaces. Cannabis was receiving attention because of its complex chemical composition which remains in the blood for many days after a user is no longer intoxicated. The fairness component is challenged in the court of law due to the human rights component which allows people to use it in their private space.

Conclusions from Milestone 5

True to its purpose, the workshop with stakeholders achieved its main aim of presenting the research findings and to solicit further discussions, comments, and inputs. The additional insights gained from the workshop were valuable and will be incorporated in the study to enrich the research output, ultimately leading to the development of a set of rules for cannabis management in the SAMI workplace

From the robust discussions conducted during the workshop, it became clear that more guidance was required on several items. The first recognition was a need to distinguish between mandatory or pre-defined testing for cannabis during medicals or medical surveillance and daily screening and monitoring of employees for pre-shift work or anytime during the day. This distinction is necessary to craft appropriate strategies that

are specific for purposes of either fitness to work or maintenance of health and safety daily. Mandatory medical tests for cannabis should predominantly be used to determine fitness to work while daily screening for cannabis should be meant to remove employees who are impaired from the workplace to ensure health and safety of all employees.

The testing methods for mandatory medicals such as urine and blood tests should remain unchanged. However, urine and blood tests are not practical for daily screening for cannabis due to their invasive nature and associated costs. Nevertheless, other non-invasive tools for daily drug screening such as saliva and real-time impairment testing, appear to be available on the market following the rise of advanced artificial intelligence powered technologies and should be researched further for validity and authenticity. These could then be used for cannabis screening during pre-shifts and randomly daily to complement the current practices of suspecting and selecting employees who appear impaired.

Cut-off limits of cannabis impairment are required in the SAMI for easy standardisation and monitoring as these values will indicate what further recourse should be undertaken for offenders. Employers remain responsible for OHS at mining operations and should set rules that employees should adhere to using a common law of contract to ensure fairness. However, the contents of the law of contract should be ethically sound, legally defensible and scientifically accurate.

In terms of the implementation of screening for cannabis and other drugs, it is proposed that the risk-based approach be considered including rules for different work categories and the nature of different job types. As an example, a winch operator in underground mining should be subjected to stricter screening methods compared to an office-based employer whose potential risk profile is much less. Even so, the rules for drug screening and testing should be applied consistently across all types of drugs and alcohol monitoring to ensure the uninterrupted health and safety of employees daily.

3.6 MILESTONE 6

Results and Outcomes per Milestone 6

The aim of milestone 6 was to develop a guidance document or a set of rules for testing and assessing the allowable levels or limits of cannabis use and its effects on the workplace that can be utilised in the SAMI.

The guidance document was developed and documented under the following sub-sections:

- Part A – The guideline
- Part B – Proposed updates to the code of practice (COP)
- Part C – Guidance for cannabis testing and assessment
- Part D – Implementation Plan

PART A – THE GUIDELINE

1. FOREWORD

- 1.1. In 2018, a Constitution Court of South Africa decriminalised the use, possession, and cultivation of cannabis in private, following a series of court cases related to human rights violation as stipulated in Chapter 2 of the Constitution of the Republic of South Africa Act No. 108 of 1996. Section 2 of the Cannabis for Private Purpose Act No. 7 of 2024 (CPP) allows an adult to possess or use cannabis in the private space and for private purposes.
- 1.2. The CPP statute only clarifies the possession or use of cannabis in one's private space and capacity but does not clarify how it should be treated in the workplace thereby creating a gap in interpretation and application for purposes of occupational health and safety. However, other statutes specific to workplace safety are available to address issues of substance use and abuse which supersede the CPP.

- 1.3. For the SAMI, these statutes include Section 8 of the Occupational Health and Safety Act No. 85 of 1993 (OHSA), Section 7 of the Mine Health and Safety Act No. 29 of 1996 (MHSA) and Section 2A of the General Safety Regulation within the OHSA, which empowers the employer to take every reasonable measure possible to ensure a safe working environment that does not pose any health risk to the employees.
- 1.4. Other complimentary statutes include Sections 6 and 7 of the Employment Equity Act No. 55 of 1998 (EEA) and Section 10 under Schedule 8 of the Labour Relations Act No. 66 of 1995 (LRA), which accords employers rights to establish conditions of employment under which employees should work within. These employment conditions then form basis for fairness in processes where there is a contravention.
- 1.5. In terms of these statutes, mining companies in South Africa have adopted a 'zero-tolerance' approach to alcohol and substance abuse due to the dangerous nature of the work in the mining industry. Decriminalisation of cannabis does not overrule this standard whatsoever. Instead, employers are compelled to find a workaround without trampling on human rights provisioned in the CPP.
- 1.6. What exacerbates the cannabis conundrum for workplace safety is that cannabis contains intricate chemical compounds which enable its metabolites to linger in the body system much longer regardless of intoxication levels, compared to alcohol. This complicates drug testing because the presence of cannabis in the body system does not necessarily mean that the user is intoxicated or under its influence. This renders some of the existing drug testing and assessment methods inadequate requiring revision to specify how cannabis should be managed in the workplace.
- 1.7. This guideline has been developed to provide a framework that should be adopted for managing cannabis in the South African Mining Industry (SAMI).

2. OBJECTIVE OF THE GUIDELINE

The objective of this guideline is to assist all relevant stakeholders responsible for substance abuse control in the SAMI to achieve the following, if implemented and complied with:

- 2.1. Revise the existing drug and substance abuse policies to specify the allowable blood cut-off limits of cannabis in the body system while at work.
- 2.2. Revise the existing drug testing procedures and assessment tools to specifically include the management of cannabis.
- 2.3. Ensure that the employment contract is updated to cover all aspects of cannabis requirements in the workplace including declarations, testing procedures and consequence management of non-compliance, which all employees should adhere to.
- 2.4. Incorporate cannabis into the procedures for drug surveillance and monitoring to ensure ongoing improvement and promotion of health and safety in the SAMI workplace.

3. SCOPE OF THE GUIDELINE

- 3.1. This guideline covers the general and basic approach for cannabis management in the workplace in relation to fitness to perform work at a mine, advising on some measures that could be implemented to manage cannabis successfully while upholding human rights.
- 3.2. This guideline does not stipulate specific advice on the various scenarios in the workplace related to cannabis testing and assessment. However, the aspects of drug and substance control not addressed in this guideline are assumed to be considered and covered in the existing statutes and codes of conduct for drug and substance abuse management.

- 3.3. The stakeholders responsible for substance abuse control should ensure that they implement a robust cannabis management framework that is ethically sound, legally defensible, and scientifically accurate.

4. DEFINITIONS AND ACRONYMS

“COP” means Code of Practice in terms of section 9 of the MHSA.

“EEA” means Employment Equity Act No. 55 of 1998.

“LRA” means Labour Relations Act No 66. of 1995.

“MHSA” means Mine Health and Safety Act No. 29 of 1996 as amended.

“OHSA” means Occupational Health and Safety Act No. 85 of 1993.

“SAMI” means South African Mining Industry.

“THC” means Delta9-tetrahydrocannabinol which is a chemical compound found in cannabis that produces a psychoactive effect.

“OMP” means a medical practitioner who holds a qualification in occupational medicine or an equivalent qualification, recognised by the Health Professions Council of South Africa.

“OHN” means an occupational health nurse who holds a qualification in nursing or an equivalent qualification, recognised by the Health Professions Council of South Africa.

“PWC” means physical work capacity which is the maximum amount of physical effort an individual can sustain.

“FWC” means functional work capacity which is the ability to perform specific job-related tasks.

PART B – PROPOSED UPDATES TO THE CODE OF PRACTICE (COP)

1. COP ON THE MINIMUM STANDARDS TO PERFORM WORK AT A MINE

- 1.1 The mandatory CoP on the minimum standards of fitness to perform work at a mine provides guidance on the most common approaches to be followed by the relevant personnel to determine fitness. The section related to alcohol, or substance abuse or dependency falls under the mental and behavioural disorders sub-section in section 8.5.5.2 and states as follows:

1.1.1 To be guided by the Alcohol and Substance Abuse Policy, as directed by the Health and Safety Committee at the mine.

However, Since the alcohol and substance abuse policy is a subset of the overall employment policy, it warrants inclusion in this mandatory CoP. Section 8.5.5.2 should therefore be updated to include the provisions of the employment contract as follows:

*1.1.2 To be guided by the Alcohol and Substance Abuse Policy, as directed by the Health and Safety Committee at the mine **and the provisions of the employment contract.***

PART C – GUIDANCE FOR CANNABIS TESTING AND ASSESSMENT

1. ALCOHOL AND SUBSTANCE ABUSE POLICY

- 1.1. In accordance with the stipulations of the MHSA, the OHSA, the LRA and the EEA, employers have the right to refuse entry to or expel from the workplace, anyone appearing intoxicated, even if it is just a suspicion of substance use, because this is outlined in the employment contract.
- 1.2. To clarify the management of cannabis in the workplace, it is crucial that the existing alcohol and substance abuse code of conduct be revised to embed cannabis and the implication for non-compliance, which may lead to

disciplinary action that might result in dismissal. The revision should include the allowable cut-off limits of Delta9-tetrahydrocannabinol (THC) in the blood system and the associated general contractual requirements for employment as follows:

1.3. Allowable cut-off limits of THC

- i. No employee should have a blood THC concentration of more than **1 ng/ml** in their body system while at work, if they work in dangerous environments, if they are involved in handling of machinery, equipment, vehicles, and any movable objects as part of their daily duties.
- ii. No employee should have a blood THC concentration of more than **2 ng/ml** in their body while at work.

2. EMPLOYMENT CONTRACTUAL REQUIREMENTS

- 2.1. Before entering into a contractual agreement with the employer, the employees should be made to understand the terms and conditions pertaining to cannabis testing and that positive test outcomes, above the stipulated blood THC cut-off limits, will be subjected to the disciplinary procedures applicable for substance abuse. The employee should enter into the contractual agreement only once they have agreed to these terms and conditions.
- 2.2. The policy should clearly stipulate the reason for the inclusion of the THC concentration thresholds in the assessment requirements, which should be to uphold health and safety in the workplace while adhering to fairness of employment conditions as provisioned in the OHSA and the LRA, respectively.
- 2.3. The policy should provide that it be compulsory for employees to declare if they are using cannabis for medical purposes or if they are on prescription medications that could influence the cannabis test outcomes, prior to the test. This declaration should be made to the health practitioner or any personnel responsible for cannabis testing.

- 2.4. If the cannabis test results turn out to be positive, it should be clarified that employees cannot use medication of any kind, as a mitigating circumstance during the disciplinary process if they did not declare it prior to the tests. This is extremely vital for potential procedural disputes.
- 2.5. Once the employment contract is entered into, it is legal and binding on both the employer and employee. Refusal to be tested for cannabis for whatsoever reason, or a positive cannabis test outcome above the allowable blood cut-off thresholds will be in breach of contract.
- 2.6. All employees should be subjected to this policy as an inherent requirement of employment and to uphold the zero-tolerance policy against alcohol and drug abuse. There should be no exceptions to cannabis testing.
- 2.7. Employers should revise their drug support programs to include specific tailor-made mechanisms to manage cannabis-related drug abuse cases.
- 2.8. Employers should communicate the changes made to the employment contract about cannabis and increase training and awareness programs related to the impact of cannabis on mental health and safety at work and outside of work.

3. CONTRACTORS AND VISITORS

- 3.1. The terms and conditions pertaining to cannabis testing must be referenced in the contractual agreement between the mining companies and the contractors.
- 3.2. The contractors should comply with the cannabis testing procedures for the duration of the contract period.
- 3.3. Visitors to a mine must be informed about the cannabis provisions and that they can be screened and tested if suspected of intoxication.

4. CANNABIS TESTING PROCEDURES AND ASSESSMENT TOOLS

- 4.1. Employees and contractors should be inducted to the cannabis testing process. Prior to testing, the prescribed allowable cut-off limits of cannabis in the blood system must be reiterated to the employees to ensure procedural correctness as a precautionary measure should the test results lead to disciplinary action.
- 4.2. The reasons for testing should be explained to the employees in reference to the employment contract or contractor agreement. Any employee or contractor who does not agree to be tested at any given point in time will be contravening the terms of their contractual agreement and should be subjected to disciplinary action.
- 4.3. The existing procedure for drug and substance testing in the SAMI consists of screening and detection followed by confirmation. This procedure and practices will apply to cannabis testing.
- 4.4. **Cannabis screening**
 - 4.4.1. Cannabis should be screened using the observational techniques and impairment testing.
 - i. Observational techniques using various sobriety testing mechanisms or any other layperson's methods of detection should be used to screen for cannabis through observed bloodshot/glossy/blurry/reddened eyes, slurred speech, delayed reaction, aggressive or confrontational behaviour and unsteadiness.
 - ii. Employers should consider using impairment and other testing technology available on the market to screen for the symptoms associated with the presence of cannabis.

4.4.2. As per the existing standard screening procedures for drug use, screening for cannabis should be conducted by any staff member responsible for health and safety in the workplace. This may include mine overseers, production managers, mine operators, shift managers and the general management.

4.4.3. If the screening shows possible intoxication, the employee, contractor or visitor must be referred and subjected to further clinical testing to detect the presence of cannabis in the body system.

4.5. Cannabis detection

4.5.1. Cannabis should be detected using clinical chemistry techniques which should preliminarily detect THC in the body system.

4.5.2. Cannabis should be detected using the following non-invasive and semi-invasive tools:

- i. Urine drug test using urine test strips
- ii. Oral fluid drug test using disposable saliva tests
- iii. Hair follicle drug test
- iv. Sweat drug test using sweat patches
- v. Nail drug test using fingernail drug panels.

4.5.3. Because drug testing is a cost factor, employers should find solutions that are best suited for their testing needs without compromising the quality and effectiveness of testing.

4.5.4. The procedure to detect cannabis in the body system should be conducted by qualified health professionals such as the OMP or the OHN in a controlled space.

4.5.5. The existing indicators and thresholds used to detect the presence of drugs in the body system should be maintained and applied to cannabis.

4.5.6. If the results of the drug tests indicate the present of cannabis, the employee or contractor must be referred for blood tests to confirm the THC limits in the blood system.

4.5.7. If a visitor who is suspected of intoxication, is screened, and referred for cannabis detection, and the drug test results are positive for cannabis, they should be removed from the workplace.

4.6. Cannabis confirmation

4.6.1. Confirmation of the presence of THC in the body system, including the confirmation of the allowable cut-off limits of THC concentration, should be conducted using the existing methods for drug confirmation which is through blood tests.

4.6.2. The following should be adhered to:

- i. Blood tests should be conducted by a qualified health practitioner such as a phlebotomist in a controlled space.
- ii. The blood sample should be stored at a temperature between 2 to 10°C and transported to the laboratory within 24 hours where it should be analysed by qualified toxicologists and scientists.
- iii. Once analysed and compiled by the toxicologists or scientists, a report containing detailed results should be securely communicated and delivered back to the qualified health practitioner who had conducted the blood tests. Thereafter, the existing procedures will be applied.
- iv. It is important to observe this procedure to safeguard against legal dispute should the process be challenged in a court of law.

4.7. The frequency of testing should follow the surveillance and monitoring guidelines provided in section 5.

- 4.8. Throughout the process of cannabis testing, detailed documentation should be maintained showing every screening, detection, and confirmation outcome. The test sheet should show the process that was followed and that the employee was aware of the test processes and outcomes.
- 4.9. In cases of a confirmed positive cannabis test outcome above the allowable cut-off thresholds in the blood system, the procedures for managing contraventions in the existing alcohol and substance abuse policy and the human resource processes should be utilized.

The employee or contractor will be subjected to disciplinary action and may be found guilty of contravening the drug policy. The appropriateness of the sanction will depend on a few factors including mitigating circumstances such as whether the employee made any declarations prior to the tests or if it is the inherent requirements of the type of work.

5. CANNABIS SURVEILLANCE AND MONITORING

- 5.1. The surveillance and monitoring of cannabis will follow the existing risk-based framework for exposure surveillance consisting of initial, periodic/routine/ongoing and exit examinations.

However, exit examination is out of scope for this guideline as it does not apply to on-going maintenance of health and safety at a mine.

5. Initial examinations

- 5.2.1. As part of the baseline measurements, the OMP must endeavour to determine the inherent profile of the employees' cannabis use.
- 5.2.2. Other than the standard drug tests conducted for baseline medicals, the history of cannabis use should be established using a health questionnaire. If there is historical use of cannabis and any resultant mental issues, the purpose for using, the frequency of use and the age of use should be documented.

- 5.2.3. The purpose of use will reveal if it is for medicinal, or religious, or for recreational purposes.
- 5.2.4. If the employee or contractor has a history of using cannabis for medicinal and religious purposes, and the initial drug test results are above the allowable limits, the employer should implement the following:
- i. Subject the employee or contractor to further PWC and FWC assessments to determine fitness to work.
 - ii. The results of the PWC and FWC assessments will determine what level of strenuous work an employee can endure and what job types they are suitable for.
- 5.2.5. Knowledge of this information will empower the employer to assess and quantify the risk associated with drug dependency and possible mental health of the employees and contractors which will assist in preventing work related accidents and implementation of support programs.
- 5.2.6. The baseline information compiled on cannabis use for medicinal and religious purposes should be documented in detail and used for continuous monitoring to ensure health and safety.

6. Periodic/routine/ongoing surveillance and monitoring

- 5.3.1 The purpose of periodic or routine surveillance and ongoing monitoring of cannabis use in the workplace is to deter abuse, identify intoxication, and detect inappropriate, irresponsible and negligent use.
- 5.3.2. Routine surveillance and ongoing monitoring of cannabis use should follow a risk-based approach based on the outcomes of the baseline examinations, the nature of work and the work environment.
- 5.3.3. If the baseline examinations suggest dependency on cannabis for medicinal or religious purposes or show a history of abuse and mental health issues, then

management should determine the frequency at which the employee should be tested and monitored to ensure that the risk of repeated abuse resulting in accidents in the workplace or inability to perform work is mitigated.

5.3.4. The nature of work and the work environment play a crucial role in determining the frequency of cannabis surveillance, screening and monitoring, outside of the normal medical surveillance.

- i. For work deemed dangerous such as handling of machinery, equipment, vehicles, and any movable objects, the frequency of screening should be conducted daily during pre-shifts and intra-day multiple times, as much as is necessary to identify and remove intoxicated employees from the workplace. Ongoing screening should be conducted using observational techniques, sobriety, and impairment tests.
- ii. For the working environments deemed to be dangerous, such as environments with risk of explosions, cave-ins, flooding and exposure to toxic air, cannabis surveillance, screening and monitoring should be done daily during pre-shift and intra-day multiple times to ensure that intoxicated employees are identified and swiftly removed from the environment.
- iii. For work of a managerial nature, high responsibility or work that could result in financial, operational, or commercial loss, the frequency of cannabis surveillance and monitoring should be at least quarterly.
- iv. For the rest of the work categories deemed to be less risky, cannabis surveillance and monitoring may be conducted at reduced routine or planned intervals based on the outcomes of risk-based assessments.

PART D – IMPLEMENTATION

1. IMPLEMENTATION PLAN

- 1.1. The employer should prepare an implementation plan that will enable successful implementation of the guideline. The implementation plan should make provisions for issues such as organisation structures, roles and responsibilities and various functionaries.
- 1.2. Information may be graphically represented to facilitate easy interpretation of the data and to highlight trends for the purposes of risk assessment.

2. COMPLIANCE WITH THE GUIDELINE

- 2.1. The employer should institute specific measures for monitoring and ensuring compliance with the guideline.

3. ACCESS TO THE GUIDELINE

- 3.1. The employer should ensure that a complete guideline and all the related documents are kept readily available at the mine for examination by any affected person.
- 3.2. Furthermore, the employer should ensure that all employees are fully conversant with those sections of the guideline relevant to their respective areas of responsibilities.
- 3.3. A registered trade union with members at the mine or where there is no such union, a health and safety representative on the mine, or, if there is no health and safety representative, an employee representing the employees on the mine, should be provided with a copy. A register must be kept of such persons or institutions with copies to facilitate updating of such copies.

Conclusions from Milestone 6

The knowledge from the previous milestones was synthesized to extract the required guidelines. Ultimately, the guidelines were proposed for adoption in the SAMI and include additions to the code of conduct for the existing alcohol and substance abuse policy, the employment contractual requirements, cannabis testing procedures and assessment tools and cannabis surveillance and monitoring. Furthermore, amendments were proposed to certain sections of the mandatory CoP on minimum standards of fitness to perform work at a mine. Overall, the methods utilised for this milestone yielded the intended results.

4 CONCLUSIONS

To address the problem statement identified for this research project, a robust research methodology was implemented. This included a comprehensive review of the literature on cannabis legislation, definitions, uses, effects, impact on workplace safety and productivity, and testing in the workplace. This was followed by a survey to understand the perspectives of industry stakeholders about cannabis decriminalisation and the impact on the existing drug testing and assessment methods.

A significant part of this process was to benchmark the allowable blood limits of cannabis use. This process provided clear cannabis limits for specific work categories that should be implemented in the SAMI. The research findings were presented back to the industry stakeholders for enrichment towards the development of a guidance document for testing and assessing the allowable blood limits of cannabis use in the workplace that should be adopted by the SAMI

Overall, the methods used in this research study yielded the intended result which is to provide guidance on the management of cannabis in the SAMI.

5 LESSONS LEARNED

The following major lessons were learned during the course of this research study:

1. It is important to plan for unforeseeable circumstances and mitigating factors in the project process, especially for expert resources. Lack of this would result in delayed deliveries on the planned milestones.
2. It is crucial to have more than one resource expert for a specific technical piece of work for continuity.
3. So much can be done with technology, in terms of conducting online surveys, scheduling invitations and interactivity during workshops.
4. For hybrid workshops, it is important to maintain stable internet connectivity with the virtual participants for maximum participation.
5. It is important to constantly engage with the virtual participants interactively in order not to lose them.

6 RECOMMENDATIONS

6.1 Recommendations for further research

Based on the findings from this study, the following research is recommended:

- a. Case studies should be conducted on the association of cannabis use with accidents and incidents in the SAMI workplace.
- b. Determine and quantify the full impact of cannabis impairment on mining operations in terms of productivity and safety.
- c. Research of the allowable limits for cannabis use in urine and saliva.
- d. What technologies can be used for impairment testing in real-time?
- e. What is the most effective method for screening cannabis in real-time?
- f. Explore non-invasive methods that should be used for daily screening of cannabis and other drugs

6.2 Recommendations for implementation for the sector

Based on the outcomes of the research study, the following items are recommended for implementation in the SAMI:

- a. The guidelines for testing and assessing the allowable limits of cannabis use in the SAMI workplace should be disseminated to the policy makers for adoption and implementation.

- b. An implementation plan should be drafted by each employer on how they will implement the guidance document.
- c. Consider a risk-based approach to revise the existing employment policies and standard drug policies and procedures.
- d. Employers should implement more awareness and training initiatives on the impact of cannabis on workplace safety and productivity.
- e. Employers should review the existing employment contracts to clarify the management of cannabis in the workplace as proposed in the guidance document.

7 REFERENCES

- Abel, E.L. (2013). Marihuana: The First Twelve Thousand Years. *Springer Science & Business Media*. pp. 133–190.
- Agius, R., Nadulski, T., Kahl, H.G. and Dufaux, B., 2012. Significantly increased detection rate of drugs of abuse in urine following the introduction of new German driving licence re-granting guidelines. *Forensic science international*, 215(1-3), pp.32-37.
- Ajani AFY. 2010. Alcohol and cannabis use among mineworkers in South Africa: University of the Witwatersrand; 2010.
- Alberto Blandino, Rosy Cotroneo, Stefano Tambuzzi, Domenico Di Candia, Umberto Genovese, Riccardo Zoja. 2022. Driving under the influence of drugs: Correlation between blood psychoactive drug concentrations and cognitive impairment. A narrative review taking into account forensic issues, *Forensic Science International: Synergy*, Volume 4, 2022, 100224, ISSN 2589-871X,
- Alonso-Esteban, J.I., Pinela, J., Ćirić, A., Calhelha, R.C., Soković, M., Ferreira, I.C., Barros, L., Torija-Isasa, E. and de Cortes Sánchez-Mata, M., 2022. Chemical composition and biological activities of whole and dehulled hemp (*Cannabis sativa* L.) seeds. *Food Chemistry*, 374, p.131754.
- Alshaarawy, O., Balasubramanian, G. and Venkatesan, T., 2023. Cannabis use in the United States and its impact on gastrointestinal health. *Nutrition in Clinical Practice*.
- Alves, V.L., Gonçalves, J.L., Aguiar, J., Teixeira, H.M. and Câmara, J.S., 2020. The synthetic cannabinoids phenomenon: from structure to toxicological properties. A review. *Critical Reviews in Toxicology*, 50(5), pp.359-382.
- Andreae, M.H., Carter, G.M., Shaparin, N., Suslov, K., Ellis, R.J., Ware, M.A., Abrams, D.I., Prasad, H., Wilsey, B., Indyk, D. and Johnson, M., 2015. Inhaled cannabis for chronic neuropathic pain: a meta-analysis of individual patient data. *The Journal of Pain*, 16(12), pp.1221-1232.

- Anywar, G., Kakudidi, E., Tugume, P. and Asiimwe, S., 2022. The Cannabis/Marijuana (Cannabis sativa L.) Landscape in Africa: An Overview of its Cultivation and Legal Aspects. *Cannabis/Hemp for Sustainable Agriculture and Materials*, pp.297-310.
- Appendino, J.P., Boelman, C., Brna, P.M., Burneo, J.G., Claassen, C.S., Connolly, M.B., De Guzman, M.V., Federico, P., Floyd, D., Huntsman, R.J. and Javidan, M., 2019. Position statement on the use of medical Cannabis for the treatment of Epilepsy in Canada: By the Canadian League Against Epilepsy medical therapeutics committee, invited experts and collaborators. *Canadian Journal of Neurological Sciences*, 46(6), pp.645-652.
- Arkell, T.R., Spindle, T.R., Kevin, R.C., Vandrey, R. and McGregor, I.S., 2021. The failings of per se limits to detect cannabis-induced driving impairment: Results from a simulated driving study. *Traffic injury prevention*, 22(2), pp.102-107.
- Arkell, T.R., Manning, B., Downey, L.A. and Hayley, A.C., 2023. A semi-naturalistic, open-label trial examining the effect of prescribed medical cannabis on neurocognitive performance. *CNS drugs*, 37(11), pp.981-992.
- Asbridge M, Hayden JA, Cartwright JL. 2012. Acute cannabis consumption and motor vehicle collision risk: Systematic review of observational studies and meta-analysis. *Bmj*. 2012; 344:e536.
- Ashley, D.L., De Jesús, V.R., Abulseoud, O.A., Huestis, M.A., Milan, D.F. and Blount, B.C., 2020. Urinary acrylonitrile metabolite concentrations before and after smoked, vaporized, and oral cannabis in frequent and occasional cannabis users. *International journal of environmental research and public health*, 17(18), p.6438.
- Ashton CH. 1999. Adverse effects of cannabis and cannabinoids. *British Journal of Anaesthesia*. 1999; 83(4):637-49.
- Augsburger, M., Donzé, N., Ménétrey, A., Brossard, C., Sporkert, F., Giroud, C. and Mangin, P., 2005. Concentration of drugs in blood of suspected impaired drivers. *Forensic science international*, 153(1), pp.11-15.

- Avila EN. Minimum Levels of Controlled Substances or Their Metabolites in Blood to Establish Presence of Controlled Substance. *Pennsylvania Bulletin*. [2011] April 30. Accessed May 23, 2024.; [Wash Rev Code § 46.61.502]).
- Aysolmaz, B., Nemeth, M. and Iren, D., 2021, June. A method for objective performance benchmarking of teams with process mining and DEA. In *29th European Conference on Information Systems (ECIS 2021): Human values crisis in a digitizing world* (p. 1773). AIS Electronic Library.
- Bachhuber, M., Arnsten, J.H. and Wurm, G., 2019. Use of cannabis to relieve pain and promote sleep by customers at an adult use dispensary. *Journal of psychoactive drugs*, 51(5), pp.400-404.
- Bakke, E., Høiseth, G., Arnestad, M. and Gjerde, H., 2019. Detection of drugs in simultaneously collected samples of oral fluid and blood. *Journal of analytical toxicology*, 43(3), pp.228-232.
- Balant, M., Gras, A., Ruz, M., Valles, J., Vitales, D. and Garnatje, T., 2021. Traditional uses of Cannabis: An analysis of the CANNUSE database. *Journal of Ethnopharmacology*, 279, p.114362.
- Baldwin, L. (2018). Internal and external validity and threats to validity. *Research Concepts for the Practitioner of Educational Leadership*, 31–36.
- Bandawe, G., 2022. Medical cannabis and cannabidiol: A new harvest for Malawi. *Malawi Medical Journal*, 34(2), pp.138-142.
- Bapir, L., Erridge, S., Nicholas, M., Pillai, M., Dalavaye, N., Holvey, C., Coomber, R., Hoare, J., Khan, S., Weatherall, M.W. and Rucker, J.J., 2023. Comparing the effects of medical cannabis for chronic pain patients with and without co-morbid anxiety: A cohort study. *Expert Review of Neurotherapeutics*, 23(3), pp.281-295.

- Bartlett A, Lesch M, Golder S, McCambridge J. 2023. Alcohol policy framing in South Africa during the early stages of covid-19: Using extraordinary times to make an argument for a new normal. *BMC Public Health*. 2023; 23(1):1877. doi:10.1186/s12889-023-16512-y
- Bastien, M., Mezaache, S., Donadille, C., Martin, V., Appel, L., Lebrun, M., Briand Madrid, L., Barré, T. and Roux, P., 2023. Exclusive Therapeutic Use of Cannabis in a Large Sample of Daily Cannabis Users in France: A Cross-Sectional Survey. *Journal of Psychoactive Drugs*, pp.1-11.
- Battistella, G.; Fornari, E.; Thomas, A.; Mall, J.F.; Chtioui, H.; Appenzeller, M.; Annoni, J.M.; Favrat, B.; Maeder, P.; Giroud, C. Weed or wheel! FMRI, behavioural, and toxicological investigations of how cannabis smoking affects skills necessary for driving. *PLoS One*, 2013, 8, e52545.
- Beauregard, R. A. (2020). *Advanced introduction to planning theory*. Edward Elgar Publishing.
- Berghaus, G., Sticht, G., Grellner, W., Lenz, D. and Naumann Th, W.S., 2010. Meta-analysis of studies concerning the effects of medicines and illegal drugs including pharmacokinetics on safe driving.
- Bhattacharya, A., 2019. Financial headache: the cost of workplace hangovers and intoxication to the UK economy.
- Bidwell LC, Ellingson JM, Karoly HC, YorkWilliams SL, Hitchcock LN, Tracy BL, et al. 2020. Association of naturalistic administration of cannabis flower and concentrates with intoxication and impairment. *JAMA psychiatry*. 2020;77(8):787-96.
- Bicket, M.C., Stone, E.M. and McGinty, E.E., 2023. Use of cannabis and other pain treatments among adults with chronic pain in US states with medical cannabis programs. *JAMA network open*, 6(1), pp.

- Boggs DL, Cortes-Briones JA, Surti T, Luddy C, Ranganathan M, Cahill JD, et al. 2018. The dose-dependent psychomotor effects of intravenous delta-9-tetrahydrocannabinol (δ 9-thc) in humans. *Journal of Psychopharmacology*. 2018; 32(12):1308-18.
- Bonini, S.A., Premoli, M., Tambaro, S., Kumar, A., Maccarinelli, G., Memo, M. and Mastinu, A., 2018. Cannabis sativa: A comprehensive ethnopharmacological review of a medicinal plant with a long history. *Journal of ethnopharmacology*, 227, pp.300-315.
- Borrelli, I., Santoro, P.E., Gualano, M.R., Perrotta, A., Daniele, A., Amantea, C. and Moscato, U., 2022. Alcohol consumption in the workplace: a comparison between European Union Countries' policies. *International journal of environmental research and public health*, 19(24), p.16964.
- Burchell, Jonathan M. (2013). *Principles of Criminal Law*. South Africa: Juta and Company Ltd. p. 798.
- Bowman A, Lehmann-Grube K. 2023. Inclusive Development in the South African Cannabis Industry: Assessing the Challenges. 2023.
- Broyd SJ, van Hell HH, Beale C, Yuecel M, Solowij N. 2016. Acute and chronic effects of cannabinoids on human cognition—a systematic review. *Biological psychiatry*. 2016; 79(7):557-67.
- Brubacher JR, Chan H, Staples JA. 2020. Cannabis-impaired driving and Canadian youth. *Paediatrics & Child Health*. 2020; 25(Supplement_1):S21-S5.
- Brubacher, J.R., Chan, H., Erdelyi, S., Macdonald, S., Asbridge, M., Mann, R.E., Eppler, J., Lund, A., MacPherson, A., Martz, W. and Schreiber, W.E., 2019. Cannabis use as a risk factor for causing motor vehicle crashes: a prospective study. *Addiction*, 114(9), pp.1616-1626.
- Cai, Q.L., Peng, D.J., Chen, J.W., Luo, H.L., Ou, S.Y., Huang, M.L. and Jiang, Y.M., 2021. Impact of lead exposure on thyroid status and IQ performance among school-age children living nearby a lead-zinc mine in China. *Neurotoxicology*, 82, pp.177-185.

Calabrese EJ, Rubio-Casillas A. 2018. Biphasic effects of THC in memory and cognition. *European journal of clinical investigation*. 2018 May;48(5):e12920.

Cambridge dictionary word of the year 2023. Cambridge University Press & Assessment 2024. Available from: <https://dictionary.cambridge.org/dictionary/english/intoxication>, [Last accessed: 11 February 2025].

Campeny, E., López-Pelayo, H., Nutt, D., Blithikioti, C., Oliveras, C., Nuño, L., Maldonado, R., Florez, G., Arias, F., Fernández-Artamendi, S. and Villalbí, J.R., 2020. The blind men and the elephant: Systematic review of systematic reviews of cannabis use related health harms. *European Neuropsychopharmacology*, 33, pp.1-35.

Canada. 1990. Occupational Health and Safety Act (Ontario) R.R.O. 1990, Reg 854. Mines and Mining Plants. Available from: <https://www.ontario.ca/laws/regulation/900854>. [Last accessed: 02 February 2025].

Canada. Cannabis Act (S.C. 2018, c. 16). Justice Canada. Government of Canada. Available from: <https://laws-lois.justice.gc.ca/eng/acts/C-24.5/index.html>. [Last accessed: 28 January 2025]

Canada. Canada Labour Code (R.S.C., 1985, c. L-2). Available at: <https://laws-lois.justice.gc.ca/eng/ACTS/L-2/index.html>. [Last accessed: 28 February 2025].

Canada. Non-smokers' Health Act (R.S.C., 1985, c. 15 (4th Supp.)). Available from: <https://laws-lois.justice.gc.ca/eng/acts/C-24.5/index.html>. [Last accessed: 28 February 2025].

Carnide, N., Landsman, V., Lee, H., Frone, M.R., Furlan, A.D. and Smith, P.M., 2023. Workplace and non-workplace cannabis use and the risk of workplace injury: Findings from a longitudinal study of Canadian workers. *Canadian journal of public health*, 114(6), pp.947-955.

Carnide, N., Lee, H., Landsman, V., Frone, M.R., Furlan, A.D. and Smith, P.M., 2022. Cannabis use and workplace cannabis availability, perceptions and policies among

Canadian workers: a comparison before and after the legalisation of non-medical cannabis. *Occupational and environmental medicine*, 79(12), pp.824-830.

Carnide, N., Nadalin, V., Mustard, C., Severin, C. N., Furlan, A. D., & Smith, P. M. (2023). Cannabis use among workers with work-related injuries and illnesses: results from a cross-sectional study of workers' compensation claimants in Ontario, Canada. *BMJ open*, 13(7), e072994.

Carrier, N. & Klantschnig, G., 2020. Drug policy in Africa: a history of global and regional dynamics. In *Research handbook on international drug policy* (pp. 131-144). Edward Elgar Publishing.

Case CCT 108/17; high court case numbers: 8760/13, 7295/13 and 4153/13. Available from: <https://www.saflii.org/za/cases/ZACC/2018/30.pdf>. [Last accessed: 14 January 2025].

Cerino, P., Buonerba, C., Cannazza, G., D'Auria, J., Ottoni, E., Fulgione, A., Di Stasio, A., Pierri, B. and Gallo, A., 2021. A review of hemp as food and nutritional supplement. *Cannabis and cannabinoid research*, 6(1), pp.19-27.

Chanock, Martin (2001). *The Making of South African Legal Culture 1902-1936: Fear, Favour and Prejudice*. Cambridge University Press. pp. 92–94.

Charitos, I.A., Gagliano-Candela, R., Santacroce, L. and Bottalico, L., 2021. The Cannabis spread throughout the continents and its therapeutic use in history. *Endocrine, Metabolic & Immune Disorders-Drug Targets (Formerly Current Drug Targets-Immune, Endocrine & Metabolic Disorders)*, 21(3), pp.407-417.

Chayasirisobhon, S. 2020. Mechanisms of Action and Pharmacokinetics of Cannabis. *The Permanente Journal*, 25, pp.1-3.

Chow, R.M., Marascalchi, B., Abrams, W.B., Peiris, N.A., Odonkor, C.A. and Cohen, S.P., 2019. Driving under the influence of cannabis: a framework for future policy. *Anesthesia & Analgesia*, 128(6), pp.1300-1308.

- Coats v Dish Network LLC, 350 P.3d 849 - Colo. Supreme Court 2015. Case No. 13SC934. Available from: <https://casetext.com/case/coats-v-dish-network-llc>. [Last accessed: 02 February 2025].
- Colizzi M, Bhattacharyya S. 2018. Cannabis use and the development of tolerance: A systematic review of human evidence. *Neuroscience & Biobehavioral Reviews*. 2018; 93:1-25. doi:<https://doi.org/10.1016/j.neubiorev.2018.07.014>
- Colizzi, M., Ruggeri, M. and Bhattacharyya, S., 2020. Unraveling the intoxicating and therapeutic effects of cannabis ingredients on psychosis and cognition. *Frontiers in psychology*, 11, p.525865.
- Condon, C.A., Kennedy, E.P., Mirick, P., Goodman, D., Bunn, A.L. and Dalton, A.C., 2023. *International Benchmarking: A Global Perspective of Workplace Drug and Alcohol Testing* (No. PNNL-31409 Rev. 2). Pacific Northwest National Lab.(PNNL), Richland, WA (United States).Canada. 1985. Criminal Code (R.S.C., 1985, c. C-46). Available from: <https://laws-lois.justice.gc.ca/eng/acts/c-46/>. [Last accessed: 02 February 2025].
- Curran, H.V., Freeman, T.P., Mokrysz, C., Lewis, D.A., Morgan, C.J. and Parsons, L.H., 2016. Keep off the grass? Cannabis, cognition and addiction. *Nature Reviews Neuroscience*, 17(5), pp.293-306.
- Dada S, Erasmus J, Burnhams NH, Parry C, Bhana A, Timol F, et al. 2015. Monitoring alcohol, tobacco and other drug abuse trends in South Africa (July 1996-December 2014), phase 37. 2015.
- Dalli, M., Azizi, S.E., Azghar, A., Saddari, A., Benaissa, E., Lahlou, Y.B., Elouennass, M. and Maleb, A., 2023. Cannabis sativa L.: A comprehensive review on legislation, decriminalisation, phytochemistry, antimicrobial activity, and safety. *Journal of Food and Drug Analysis*, 31(3), p.408.

- Das RK, Kamboj SK, Ramadas M, Yogan K, Gupta V, Redman E, et al. 2013. Cannabidiol enhances consolidation of explicit fear extinction in humans. *Psychopharmacology*. 2013; 226:781-92.
- Dawadi, P., Syangtan, G., Siddiqui, M.A., Lama, B., Nepal, K., Joshi, D.R. and Bhatt, L.R., 2022. Nutritional value and antioxidant properties of Cannabis seeds from Makwanpur district of central Nepal. *Scientific World*, 15(15), pp.103-112.
- Deakins. O. 2015. Miners & marijuana. Available from: <https://ogletree.com/insights-resources/blog-posts/miners-marijuana/#:~:text=The%20Federal%20Mine%20Safety%20and%20Health%20Act&text=Persons%20under%20the%20influence%20of,of%20marijuana%20on%20mine%20property> [Last accessed: 02 February 2025].
- De Greef, J., 2015. Workplace drug testing. Available from: <https://www.lancet.co.za/wp-content/uploads/2015/07/South-Africa-WORKPLACE-DRUG-TESTING-MAY2015.pdf>. [Last accessed: 23rd February 2025].
- Devi, S., Zimmermann-Klemd, A.M., Fiebich, B.L., Heinrich, M., Gründemann, C., Steinberger, P., Kowarschik, S. and Huber, R., 2022. Immunosuppressive activity of non-psychoactive Cannabis sativa L. extract on the function of human T lymphocytes. *International Immunopharmacology*, 103, p.108448.
- Di Ciano, P., Brands, B., Fares, A., Wright, M., Stoduto, G., Byrne, P., McGrath, M., Hasan, O., Le Foll, B., Wickens, C. M. 2023. The utility of THC cutoff levels in blood and saliva for detection of impaired driving. *Cannabis and Cannabinoid Research*, 8(3), 408-413. doi: 10.1089/can.2022.0187
- Di Risio M, Gowd P. 2022. The role of genetics in the use of cannabis. In: Valani R, editor. *Cannabis use in medicine: A concise handbook*. Cham: Springer International Publishing; 2022. p. 53-61. Dominguez, H., 2021. Marijuana regulation in Colombia and Uruguay: A comparative policy analysis.

Du Toit, Brian M. (1991). Cannabis, alcohol, and the South African student: adolescent drug use, 1974-1985. Ohio University Center for International Studies.

DRUID, summary of main DRUID results: driving under the influence of drugs, alcohol, and medicines, 2012, TRB 91ST Annual meeting, USA Dutch Forensic Institute report, DRUID deliverable 3.2.2.

Drummer, O.H., Gerostamoulos, D., Di Rago, M., Woodford, N.W., Morris, C., Frederiksen, T., Jachno, K. and Wolfe, R., 2020. Odds of culpability associated with use of impairing drugs in injured drivers in Victoria, Australia. *Accident Analysis & Prevention*, 135, p.105389.

D'Souza DC, Perry E, MacDougall L, Ammerman Y, Cooper T, Wu Y-t, et al. 2004. The psychotomimetic effects of intravenous delta-9-tetrahydrocannabinol in healthy individuals: Implications for psychosis. *Neuropsychopharmacology*. 2004; 29(8):1558-72.

Duvall, C.S., 2019. A brief agricultural history of cannabis in Africa, from prehistory to canna-colony. *EchoGéo*, (48).

Egnell S, Villman E, Obstbaum Y. 2019. Cannabis policy and legislation in the Nordic countries publisher, Nordic Welfare Centre 2019 nordicwelfare.org/en/publikationer

Elgohary, R., Salama, A. and Omara, E.A., 2023. Protective Effects of Cannabis sativa on chemotherapy-induced nausea in a rat: Involvement of CB1 receptors. *Fundamental & Clinical Pharmacology*, 37(1), pp.137-146.

Els C, Straube S. Marijuana and the workplace. 2016. *Canadian Journal of Addiction*. 2016; 7(4):5-7.

Enever v Barloworld Equipment, a division of Barloworld South Africa (Pty) Ltd. (2022) (JS 633/20; JS926/20). *Southern African Legal Information Institute*. Available from: <https://www.saflii.org/za/cases/ZALCJHB/2022/142.html>. [Last accessed: 15 January 2025].

- Englund, A., Morrison, P.D., Nottage, J., Hague, D., Kane, F., Bonaccorso, S., Stone, J.M., Reichenberg, A., Brenneisen, R., Holt, D. and Feilding, A., 2013. Cannabidiol inhibits THC-elicited paranoid symptoms and hippocampal-dependent memory impairment. *Journal of psychopharmacology*, 27(1), pp.19-27.
- Enslin, J.J., 2022. *The cannabis cannabis-induced impairment of an employee in the workplace: what is the employer's legal position?* (Doctoral dissertation, North-West University (South Africa)).
- Erridge, S., Holvey, C., Coomber, R., Hoare, J., Khan, S., Platt, M.W., Rucker, J.J., Weatherall, M.W., Beri, S. and Sodergren, M.H., 2023. Clinical Outcome Data of Children Treated with Cannabis-Based Medicinal Products for Treatment Resistant Epilepsy—Analysis from the UK Medical Cannabis Registry. *Neuropediatrics*, pp.174-181.
- Enslin, J.J., 2022. *The cannabis cannabis-induced impairment of an employee in the workplace: what is the employer's legal position?* (Doctoral dissertation, North-West University (South Africa)).
- Evans, R. 2019. Drugs and cannabis abuse in the workplace – The laws, testing and safety. Available from: <https://www.mmpa.org.za/wp-content/uploads/2019/10/DRUG-AND-CANNABIS-ABUSE-IN-THE-WORKPLAC-law-testing-and-safety.pdf>. [Last accessed: 25 January 2025].
- Fabritius, M., Favrat, B., Chtioui, H., Battistella, G., Annoni, J.M., Appenzeller, M., Dao, K., Fornari, E., Lauer, E., Mall, J.F. and Maeder, P., 2014. THCCOOH concentrations in whole blood: Are they useful in discriminating occasional from heavy smokers? *Drug testing and analysis*, 6(1-2), pp.155-163.
- Farinon, B., Molinari, R., Costantini, L. and Merendino, N., 2020. The seed of industrial hemp (*Cannabis sativa* L.): Nutritional quality and potential functionality for human health and nutrition. *Nutrients*, 12(7), p.1935.

- Fell, J.C., 2020. Approaches for reducing alcohol-impaired driving: evidence-based legislation, law enforcement strategies, sanctions, and alcohol-control policies. *Alcohol, Drugs, and Impaired Driving*, pp.653-689.
- Fierro, I., González-Luque, J.C. and Álvarez, F.J., 2014. The relationship between observed signs of impairment and THC concentration in oral fluid. *Drug and alcohol dependence*, 144, pp.231-238.
- Fink, A., 2019. *Conducting research literature reviews: From the internet to paper*. Sage publications.
- Foster, B.C., Abramovici, H. and Harris, C.S., 2019. Cannabis and cannabinoids: kinetics and interactions. *The American journal of medicine*, 132(11), pp.1266-1270.
- Freeman TP, van der Pol P, Kuijpers W, Wisselink J, Das RK, Rigter S, et al. 2018. Changes in cannabis potency and first-time admissions to drug treatment: A 16-year study in the Netherlands. *Psychological medicine*. 2018; 48(14):2346-52.
- G Bossong M, Jager G, Bhattacharyya S, Allen P. 2014. Acute and non-acute effects of cannabis on human memory function: A critical review of neuroimaging studies. *Current pharmaceutical design*. 2014; 20(13):2114-25.
- Gadegbeku, B., Amoros, E. and Laumon, B., 2011, October. Responsibility study: main illicit psychoactive substances among car drivers involved in fatal road crashes. In *Annals of advances in automotive medicine/annual scientific conference* (Vol. 55, p. 293). Association for the Advancement of Automotive Medicine.
- G Bossong M, Jager G, Bhattacharyya S, Allen P. 2014. Acute and non-acute effects of cannabis on human memory function: A critical review of neuroimaging studies. *Current pharmaceutical design*. 2014; 20(13):2114-25.
- Gaize Inc. 2023. *Detect Impairment in your Workforce. Instantly.*, GAIZE, INC., Available from: <https://www.gaize.ai/workforce> [Last accessed: 22 February 2025].

- Garrisson, H., Scholey, A., Ogden, E. and Benson, S., 2021. The effects of alcohol intoxication on cognitive functions critical for driving: A systematic review. *Accident Analysis & Prevention*, 154, p.106052.
- Gilman, J.M., Schmitt, W.A., Potter, K., Kendzior, B., Pachas, G.N., Hickey, S., Makary, M., Huestis, M.A. and Evins, A.E., 2022. Identification of Δ 9-tetrahydrocannabinol (THC) impairment using functional brain imaging. *Neuropsychopharmacology*, 47(4), pp.944-952.
- Gjerde, H. and Strand, M.C., 2023. Legal limits for driving under the influence of illicit drugs: Large variations between jurisdictions. *Forensic science international: reports*, p.100336.
- Gjerde, H.; Verstraete, A.G. Estimating equivalent cutoff thresholds for drugs in blood and oral fluid using prevalence regression: a study of tetrahydrocannabinol and amphetamine. *Forensic Sci Int.*, 2011, 212, 26-30.
- Gjerde, H., Bogstrand, S.T., Jamt, R.E.G. and Vindenes, V., 2023. Crash-involved THC-positive drivers in Norway have a high frequency of polysubstance use. *Drug and alcohol dependence*, 244, p.109800.
- Gjerde, H., Langel, K., Favretto, D. and Verstraete, A.G., 2015. Detection of illicit drugs in oral fluid from drivers as biomarker for drugs in blood. *Forensic science international*, 256, pp.42-45.
- Godbole, S., Leroux, A., Brooks-Russell, A., Subramanian, P.S., Kosnett, M.J. and Wrobel, J., 2024. A Study of Pupil Response to Light as a Digital Biomarker of Recent Cannabis Use. *Digital Biomarkers*, 8(1), pp.83-92.
- Goertzen, M.J. 2017. 'Introduction to Quantitative Research and Data', *Library technology reports*, 53(4): 12-18.
- Goldstone, Richard. 1997. "The South African Bill of Rights". *Texas International Law Journal*. 32: 451-470

- Goodman, S., Wadsworth, E., Leos-Toro, C., Hammond, D. and International Cannabis Policy Study team, 2020. Prevalence and forms of cannabis use in legal vs. illegal recreational cannabis markets. *International Journal of Drug Policy*, 76, p.102658.
- Graziano, S., Vari, M.R., Pichini, S., Busardo, F.P., Cassano, T. and Di Trana, A., 2023. Hexahydrocannabinol pharmacology, toxicology, and analysis: The first evidence for a recent new psychoactive substance. *Current Neuropharmacology*, 21(12), pp.2424-2430.
- Green B, Kavanagh D, Young R. 2003. Being stoned: A review of self-reported cannabis effects. *Drug and alcohol review*. 2003; 22(4):453-60.
- Grotenhermen F. 2003. Pharmacokinetics and pharmacodynamics of cannabinoids. *Clinical Pharmacokinetics*. 2003; 42(4):327-60.
- Grotenhermen, F., Leson, G., Berghaus, G., Drummer, O.H., Krüger, H.P., Longo, M., Moskowitz, H., Perrine, B., Ramaekers, J.G., Smiley, A. and Tunbridge, R., 2007. Developing limits for driving under cannabis. *Addiction*, 102(12), pp.1910-1917.
- Gruber, S., Hudak, J. and Sagar, K., 2023. A science-and equitycentered framework to reimagine workplace cannabis testing.
- Guillén Cristiana Freixo Pau Alcubilla Faizan Mazhar Richard Turner Persoulla Nicolaou Simona Stankevičiūtė Vincent Leclerc, 2021. Establishing and evaluating a study questionnaire on knowledge and attitudes of healthcare professionals towards recreational and medical cannabis across europe. *Clinical Drug Investigation*, 41, pp.701-710.
- Hammond, D., Goodman, S., Wadsworth, E., Rynard, V., Boudreau, C. and Hall, W., 2020. Evaluating the impacts of cannabis legalisation: the International Cannabis Policy Study. *International Journal of Drug Policy*, 77, p.102698.
- Harker Burnhams, N. and Parry, C.D., 2015. The state of interventions to address substance-related disorders in South African workplaces: Implications for research, policy, and

- practice. *South African Journal of Psychology*, 45(4), pp.495-507. Hartman RL, Huestis MA. 2013. Cannabis effects on driving skills. *Clinical chemistry*. 2013; 59(3):478-92.
- Hartman, R.L., Brown, T.L., Milavetz, G., Spurgin, A., Pierce, R.S., Gorelick, D.A., Gaffney, G. and Huestis, M.A., 2015. Cannabis effects on driving lateral control with and without alcohol. *Drug and alcohol dependence*, 154, pp.25-37.
- Hazle, M.C., Hill, K.P. and Westreich, L.M., 2022. Workplace cannabis policies: A moving target. *Cannabis and cannabinoid research*, 7(1), pp.16-23.
- Hill, M.N., Haney, M., Hillard, C.J., Karhson, D.S. and Vecchiarelli, H.A., 2023. The endocannabinoid system as a putative target for the development of novel drugs for the treatment of psychiatric illnesses. *Psychological Medicine*, 53(15), pp.7006-7024.
- Hjelmeland, K., Middelkoop, G., Mørland, J. and Høiseth, G., 2024. The relationship between clinical impairment and blood drug concentration: Comparison between the most prevalent traffic relevant drug groups. *Forensic Science International*, p.112180.
- Hinton, D. and Asher, T., 2022. Workplace Safety Implications Associated with Cannabidiol (CBD) in the Workplace.
- Huestis MA. 2007. Human cannabinoid pharmacokinetics. *Chemistry & biodiversity*. 2007; 4(8):1770.
- Iftikhar, A., Zafar, U., Ahmed, W., Shabbir, M.A., Sameen, A., Sahar, A., Bhat, Z.F., Kowalczewski, P.Ł., Jarzębski, M. and Aadil, R.M., 2021. Applications of Cannabis sativa L. in food and its therapeutic potential: From a prohibited drug to a nutritional supplement. *Molecules*, 26(24), p.7699.
- Impairment Science Inc. 2025. Druid impairment testing gold standard. Available from <https://www.impairmentscience.com/>. [Last Accessed: 22 February 2025].
- International Labour Organisation. 1996. Management of alcohol- and drug-related issues in the work-place: An ILO code of practice. Geneva.

- Jasti, A. and Biswas, S., 2023. Characterisation of Elementary Industrial Hemp (Cannabis Sativa L.) Fiber and Its Fabric. *Journal of Natural Fibers*, 20(1), p.2158982.
- Jeffrey R. Brubacher, Herbert Chan, Shannon Erdelyi, Scott Macdonald, Mark Asbridge, Robert E. Mann, Jeffrey Eppler, Adam Lund, Andrew MacPherson, Walter Martz, William E. Schreiber, Rollin Brant, Roy A. Purssell. 2019. Cannabis use as a risk factor for causing motor vehicle crashes: a prospective study. *Addiction* Volume114, Issue9, 2019, Pages 1616-1626.
- Jin, H., Williams, S.Z., Chihuri, S.T., Li, G. and Chen, Q., 2018. Validity of oral fluid test for Delta-9-tetrahydrocannabinol in drivers using the 2013 National Roadside Survey Data. *Injury epidemiology*, 5, pp.1-9.
- Johnson, B.A. and Ait-Daoud, N., 2011. Pharmacotherapy for alcoholism and some related psychiatric and addictive disorders: Scientific basis and clinical findings. *Addiction Medicine: Science and Practice*, pp.943-980.
- Jones, A.W., Holmgren, A. and Kugelberg, F.C., 2008. Concentrations of cocaine and its major metabolite benzoylecgonine in blood samples from apprehended drivers in Sweden. *Forensic science international*, 177(2-3), pp.133-139.
- Jouanjus, E., Sans-Pola, C., Mainoli, B., Javid, F.A., Ekheden, I. and Working Group on Medical Cannabis Projects of the EACPT Young Clinical Pharmacologists Elena Guillén Cristiana Freixo Pau Alcubilla Faizan Mazhar Richard Turner Persoulla Nicolaou Simona Stankevičiūtė Vincent Leclerc, 2021. Establishing and evaluating a study questionnaire on knowledge and attitudes of healthcare professionals towards recreational and medical cannabis across Europe. *Clinical Drug Investigation*, 41, pp.701-710.
- Junior, A.A., Gana, D., Adukeye, E. and Ahuchaogu, C., 2023. Unlocking the Socioeconomic Advantages of Cannabis Sativa L. Legalisation in African Countries: An In-Depth Review. *Global Journal of Agricultural Research*, 11(1), pp.32-52.

- Karche, T., 2019. The application of hemp (*Cannabis sativa* L.) for a green economy: A review. *Turkish Journal of Botany*, 43(6), pp.710-723.
- Karschner, E.L., Swortwood-Gates, M.J. and Huestis, M.A., 2020. Identifying and quantifying cannabinoids in biological matrices in the medical and legal cannabis era. *Clinical Chemistry*, 66(7), pp.888-914.
- Karschner, E.L.; Schilke, E.W. Lowe, R.H.; Darwin, W.D.; Herning, R.I.; Cadet, J.L.; Huestis, M.A. 2009. Implications of plasma Delta9-tetrahydrocannabinol, 11-hydroxy-THC, and 11-nor-9- carboxy-THC concentrations in chronic cannabis smokers. *J. Anal. Toxicol.*, 33, 469-477.
- Kaufmann, R., Aqua, K., Lombardo, J. and Lee, M., 2023. Observed impact of long-term consumption of oral cannabidiol on liver function in healthy adults. *Cannabis and Cannabinoid Research*, 8(1), pp.148-154.
- Kelly, B. F., & Nappe, T. M. 023). Cannabinoid Toxicity. In *StatPearls*. StatPearls Publishing.
- Kelly, L.M. and Cordeiro, M., 2020. Three principles of pragmatism for research on organisational processes. *Methodological innovations*, 13(2), p.20.
- Khoury, M., Cohen, I. and Bar-Sela, G., 2022. "The Two Sides of the Same Coin"—Medical Cannabis, Cannabinoids and Immunity: Pros and Cons Explained. *Pharmaceutics*, 14(2), p.389.
- Kienzl, M., Storr, M. and Schicho, R., 2020. Cannabinoids and opioids in the treatment of inflammatory bowel diseases. *Clinical and translational gastroenterology*, 11(1).
- Kim, H.S. and Monte, A.A., 2016. Colorado cannabis legalisation and its effect on emergency care. *Annals of emergency medicine*, 68(1), pp.71-75.
- Kitchen, C., Kabba, J.A. and Fang, Y., 2022. Status and impacts of recreational and medicinal cannabis policies in Africa: A systematic review and thematic analysis of published and "Gray" literature. *Cannabis and cannabinoid research*, 7(3), pp.239-261.

- Knapp, A.A., Lee, D.C., Borodovsky, J.T., Auty, S.G., Gabrielli, J. and Budney, A.J., 2019. Emerging trends in cannabis administration among adolescent cannabis users. *Journal of Adolescent Health*, 64(4), pp.487-493.
- Kornpointner, C., Martinez, A.S., Marinovic, S., Haselmair-Gosch, C., Jamnik, P., Schröder, K., Löffke, C. and Halbwirth, H., 2021. Chemical composition and antioxidant potential of Cannabis sativa L. roots. *Industrial Crops and Products*, 165, p.113422.
- Krosnick, J. A. (2018). Improving question design to maximize reliability and validity. *The Palgrave Handbook of Survey Research*, 95–101.
- Kronstrand, R. and Jones, A.W., 2000. DRUGS OF ABUSE| Analysis.
- Kulig, K., 2017. Interpretation of workplace tests for cannabinoids. *Journal of Medical Toxicology*, 13(1), pp.106-110.
- Lacey J, Brainard K, Snitow S. Drug Per Se Laws: A Review of Their Use in States. Washington, D.C.: National Highway Traffic Safety Administration (NHTSA). 2010. [Accessed May 15, 2024]
- Lam, H., 2019. Marijuana legalisation in Canada: Insights for workplaces from case law analysis. *Relations industrielles/Industrial Relations*, 74(1), pp.39-65.
- Lancaster, V. (2021). 10 Key Reasons Why People Smoke Marijuana: Relaxation, pain relief, a desire to fit in, and more. Available from: <https://www.psychologytoday.com/za/blog/finding-a-new-home/202110/10-key-reasons-why-people-smoke-marijuana> [Last accessed: 02 February 2025].
- Laumon, B., Gadegbeku, B., Martin, J.L. and Biecheler, M.B., 2005. Cannabis intoxication and fatal road crashes in France: population-based case-control study. *Bmj*, 331(7529), p.1371.
- Laurens JB, Carstens PA. 2020. Cannabis legalisation and testing for cannabis use in safety-and risk-sensitive environments. *South African Medical Journal*. 2020; 110(10):995-8.

- Lechleiter, D., 2024. Drug Testing and Cannabis Impairment in the Workplace: Exploring Employment Protections for Recreational Cannabis Users in the United States.
- Leggett, T., Louw, A. and Parry, C.D., 2024. Drugs and crime in South Africa a study in three cities. Available from: <https://policycommons.net/artifacts/1447998/drugs-and-crime-in-south-africa-a-study-in-three-cities/2079775/>. [Last accessed: 16 February 2025].
- Lin, L., Jung, K.M., Lee, H.L., Le, J., Colleluori, G., Wood, C., Palese, F., Squire, E., Ramirez, J., Su, S. and Torrens, A., 2023. Adolescent exposure to low-dose THC disrupts energy balance and adipose organ homeostasis in adulthood. *Cell Metabolism* 35, no.7 (2023): 1227-1241.
- Lintzeris, N., Mills, L., Suraev, A., Bravo, M., Arkell, T., Arnold, J.C., Benson, M.J. and McGregor, I.S., 2020. Medical cannabis use in the Australian community following introduction of legal access: the 2018–2019 Online Cross-Sectional Cannabis as Medicine Survey (CAMS-18). *Harm reduction journal*, 17, pp.1-12.
- Lintzeris, N., Mills, L., Abelev, S.V., Suraev, A., Arnold, J.C. and McGregor, I.S., 2022. Medical cannabis use in Australia: consumer experiences from the online cannabis as medicine survey 2020 (CAMS-20). *Harm Reduction Journal*, 19(1), pp.1-10.
- Louw, L. and Johnson, S. 2020. Medical testing for cannabis in the mining sector. *Mining Review Africa*. Available from: <https://www.miningreview.com/health-and-safety/medical-testing-for-cannabis-in-the-south-african-mining-sector/>. [Last accessed: 18 February 2025].
- Lucas, C.J., Galettis, P. and Schneider, J., 2018. The pharmacokinetics and the pharmacodynamics of cannabinoids. *British journal of clinical pharmacology*, 84(11), pp.2477-2482.
- Maarouf, H., 2019. Pragmatism as a supportive paradigm for the mixed research approach: Conceptualizing the ontological, epistemological, and axiological stances of pragmatism. *International Business Research*, 12(9), pp.1-12.

- Maccarrone, M., Di Marzo, V., Gertsch, J., Grether, U., Howlett, A.C., Hua, T., Makriyannis, A., Piomelli, D., Ueda, N. and van der Stelt, M., 2023. Goods and bads of the endocannabinoid system as a therapeutic target: Lessons learned after 30 years. *Pharmacological reviews*, 75(5), pp.885-958.
- Maccarrone, M., Rapino, C., Francavilla, F. and Barbonetti, A., 2021. Cannabinoid signalling and effects of cannabis on the male reproductive system. *Nature Reviews Urology*, 18(1), pp.19-32.
- Macnamara, S. 2023. SA mining safety initiatives targeting 'zero harm' gain traction. *African Mining*. Available from: <https://www.africanmining.co.za/2023/04/01/sa-mining-safety-initiatives-targeting-zero-harm-gain-traction/>. [Last accessed: 21 January 2025].
- Malabadi, R.B., Kolkar, K.P. and Chalannavar, R.K., 2023. CANNABIS SATIVA: Industrial hemp (fiber type)-An Ayurvedic Traditional Herbal Medicine. *International Journal of Innovation Scientific Research and Review*, 5(2), pp.4040-4046.
- Martin, J.L., Gadegbeku, B., Wu, D., Viallon, V. and Laumon, B., 2017. Cannabis, alcohol and fatal road accidents. *PLoS one*, 12(11), p.e0187320.
- Mather L. 2016. The Issue of Driving While a Relevant Drug, Δ 9-tetrahydrocannabinol, Was Present in Saliva: Evidence About the Evidence. *Griffith Journal of Law & Human Dignity* [Internet]. 2016 [26.10.2021]; 4(2).
- McCartney, D., Arkell, T.R., Irwin, C. and McGregor, I.S., 2021. Determining the magnitude and duration of acute Δ 9-tetrahydrocannabinol (Δ 9-THC)-induced driving and cognitive impairment: A systematic and meta-analytic review. *Neuroscience & Biobehavioral Reviews*, 126, pp.175-193.
- McEvoy, Erin., (2023) Amended Law in Ghana Allows for Cannabis Licenses Under Strict Conditions. Available from: <https://www.cannabissciencetech.com/view/amended-law-in-ghana-allows-for-cannabis-licenses-under-strict-conditions>. [Last accessed: 28 January 2025].

- Millar, S.A., Stone, N.L., Yates, A.S. and O'Sullivan, S.E., 2018. A systematic review on the pharmacokinetics of cannabidiol in humans. *Frontiers in pharmacology*, 9, p.1365.
- Mills, James H. (11 September 2003). *Cannabis Britannica: Empire, Trade, and Prohibition 1800-1928*. OUP Oxford. pp. 160–1.
- Minerals Council South Africa (MCSA). 2024. Fact Sheet / August 2023. Safety in mining. Available from: mineralscouncil.org.za/component/jdownloads/?task=download.send&id=1915&catid=3&m=0. [Last accessed: 28 January 2025].
- Moeller KE, Kissack JC, Atayee RS, Lee KC, editors. 2017. Clinical interpretation of urine drug tests: What clinicians need to know about urine drug screens. Mayo Clinic Proceedings; 2017: Elsevier.
- Mørland, J. and Bramness, J.G., 2020. Δ 9-tetrahydrocannabinol (THC) is present in the body between smoking sessions in occasional non-daily cannabis users. *Forensic science international*, 309, p.110188.
- Motschman, C.A., Hatz, L.E., McCarty, K.N., Merkle, E.C., Trull, T.J. and McCarthy, D.M., 2020. Event-level predictors of alcohol-impaired driving intentions. *Journal of studies on alcohol and drugs*, 81(5), pp.647-654.
- Munn, Z., Peters, M.D., Stern, C., Tufanaru, C., McArthur, A. and Aromataris, E., 2018. Systematic review or scoping review? Guidance for authors when choosing between a systematic or scoping review approach. *BMC medical research methodology*, 18, pp.1-7
- Muparadzi, T. and Mashau, P., 2023. Cannabis Industry Policy Controls and Regulations in Zimbabwe. In *Rapid Innovation and Development in the Global Cannabis Market* (pp. 17-36). IGI Global.
- Musshoff F, Madea B. 2006. Review of biologic matrices (urine, blood, hair) as indicators of recent or ongoing cannabis use. *Therapeutic Drug Monitoring*. 2006; 28(2)

- Navazesh, M. and Ahmadieh, A., 2020. Saliva and drugs of abuse. *Salivary Bioscience: Foundations of Interdisciplinary Saliva Research and Applications*, pp.371-393.
- Ncube, Leonard (9 July 2017). "Zim to legalise mbanje. Govt considers drug use for medical purposes". Available from: [Zim to legalise mbanje . . . Govt considers drug use for medical purposes | The Sunday News](#). [Last accessed: 28 January 2025]
- Newmeyer MN, Swortwood MJ, Barnes AJ, Abulseoud OA, Scheidweiler KB, Huestis MA. 2016. Free and glucuronide whole blood cannabinoids' pharmacokinetics after controlled smoked, vaporized, and oral cannabis administration in frequent and occasional cannabis users: Identification of recent cannabis intake. *Clinical Chemistry*. 2016; 62(12):1579-92.
- Niedbala RS, Kardos KW, Fritch DF, Kunsman KP, Blum KA, Newland GA, et al. 2005. Passive cannabis smoke exposure and oral fluid testing. II. Two studies of extreme cannabis smoke exposure in a motor vehicle. *J Anal Toxicol*.
- Nikathil, S., Olausson, A., Gocentas, R.A., Symons, E. and Mitra, B., 2017. Workplace violence in the emergency department: A systematic review and meta-analysis. *Emergency Medicine Australasia*, 29(3), pp.265-275.
- NUMSA obo Motsele vs Haggie Wire and Strand 2006, 2 BALR 163. Available from: <https://labourguide.co.za/misconduct/only-actual-damage-matters-in-staff-dismissals>. [Last accessed: 18 February 2025]
- NSC Policy/Position Statement: Cannabis Impairment in Safety Sensitive Positions. Available from: https://www.nsc.org/getattachment/e6e02b9a-2844-4a5d-b5b3-222fc03d5b70/w-cannabis-impairment-safety-sensitive-positions-153?srsId=AfmBOorkCIMQ7_4w3Fgd-uYHcZJ0lpzADxfH5vANclxDrv50AvlPqFuo. [Last accessed: 21 January 2025].
- Odell MS, Frei MY, Gerostamoulos D, Chu M, Lubman DI. 2015. Residual cannabis levels in blood, urine and oral fluid following heavy cannabis use. *Forensic Sci Int*. 2015

Apr;249:173-80. doi: 10.1016/j.forsciint.2015.01.026. Epub 2015 Jan 30. PMID: 25698515.

Paolo Busardo, F., Pichini, S., Pellegrini, M., Montana, A., Fabrizio Lo Faro, A., Zaami, S. and Graziano, S., 2018. Correlation between blood and oral fluid psychoactive drug concentrations and cognitive impairment in driving under the influence of drugs. *Current neuropharmacology*, 16(1), pp.84-96.

Page, M.J., McKenzie, J.E., Bossuyt, P.M., Boutron, I., Hoffmann, T.C., Mulrow, C.D., Shamseer, L., Tetzlaff, J.M., Akl, E.A., Brennan, S.E. and Chou, R., 2021. The PRISMA 2020 statement: an updated guideline for reporting systematic reviews. *International journal of surgery*, 88, p.105906.

Pape, H. and Rossow, I., 2021. Less adolescent alcohol and cannabis use: More deviant user groups? *Drug and alcohol review*, 40(1), pp.118-125.

Paré G., Trudel M.-C., Jaana M., Kitsiou S. 2015. Synthesizing information systems knowledge: A typology of literature reviews. *Information & Management*. 2015;52(2):183-199.

Parliament of South Africa. 2020. Cannabis for Private Purposes Bill. Available from: [https://www.parliament.gov.za/storage/app/media/CommitteeNotices/2023/3-april/CANNABIS FOR PRIVATE PURPOSES BILL Hemp 2023.pdf](https://www.parliament.gov.za/storage/app/media/CommitteeNotices/2023/3-april/CANNABIS_FOR_PRIVATE_PURPOSES_BILL_Hemp_2023.pdf). [Last accessed: 22 January 2025].

Paterson, Craig (2009). Prohibition & Resistance: A Socio-Political Exploration of the Changing Dynamics of the Southern African Cannabis Trade, c. 1850 – the present (PDF). South Africa: Rhodes University. Available from: [Paterson title \(fieldsofgreenforall.org.za\)](https://fieldsofgreenforall.org.za). [Last accessed: 30 January 2025]

Patrick, M.E., Graupensperger, S., Dworkin, E.R., Duckworth, J.C., Abdallah, D.A. and Lee, C.M., 2021. Intoxicated driving and riding with impaired drivers: Comparing days with alcohol, marijuana, and simultaneous use. *Drug and alcohol dependence*, 225, p.108753.

- Pearlson, G.D., Stevens, M.C. and D'Souza, D.C., 2021. Cannabis and driving. *Frontiers in psychiatry*, 12, p.689444.
- Pehrsson, A., Gunnar, T., Engblom, C., Seppä, H., Jama, A. and Lillsunde, P., 2008. Roadside oral fluid testing: comparison of the results of drugwipe 5 and drugwipe benzodiazepines on-site tests with laboratory confirmation results of oral fluid and whole blood. *Forensic science international*, 175(2-3), pp.140-148.
- Pelders, J. and Nelson, G., 2019. Contributors to fatigue of mine workers in the South African gold and platinum sector. *Safety and Health at Work*, 10(2), pp.188-195.
- Peltzer K, Phaswana-Mafuya N. 2018. Drug use among youth and adults in a population-based survey in South Africa. *South African journal of psychiatry*. 2018; 24(1):1-6.
- Peng, H. and Shahidi, F., 2021. Cannabis and cannabis edibles: a review. *Journal of Agricultural and Food Chemistry*, 69(6), pp.1751-1774.
- Petrilli, K., Ofori, S., Hines, L., Taylor, G., Adams, S. and Freeman, T.P., 2022. Association of cannabis potency with mental ill health and addiction: a systematic review. *The Lancet Psychiatry*, 9(9), pp.736-750.
- Pham, L. T. M. (2018). Qualitative approach to research a review of advantages and disadvantages of three paradigms: Positivism, interpretivism and critical inquiry. *University of Adelaide*.
- Pick W, Naidoo S, Ajani F, Onwukwe V, Hansia R, Bielu O. 2003. Prevalence of alcohol and cannabis use and reported knowledge, attitudes and practice regarding its relationship with health and safety on mines in South Africa. 2003.
- Prince MA, Conner BT. 2018. Pearson MR. Quantifying cannabis: A field study of marijuana quantity estimation. *Psychology of Addictive Behaviors*. 2018;32(4):426.
- Prince v Minister of Justice and Constitutional Development 2013 Case No: 8760 (WCC). Available from: <https://www.saflii.org/za/cases/ZAWCHC/2017/30.html>. [Accessed: 20 January 2025]

- O'Neill, V., Karanikas, N., Sav, A. and Murphy, P., 2023. Medicinal cannabis and implications for workplace health and safety: scoping review of systematic reviews. *Workplace Health & Safety*, p.21650799231157086.
- Radwan, M.M., Chandra, S., Gul, S. and ElSohly, M.A., 2021. Cannabinoids, phenolics, terpenes and alkaloids of cannabis. *Molecules*, 26(9), p.2774.
- Raja, T., 2023. Analysis of the properties of a hemp fibre derived from Cannabis sativa as a renewable source. *Biomass Conversion and Biorefinery*, 13(16), pp.15149-15159.
- Ramaekers, J.G., Moeller, M.R., van Ruitenbeek, P., Theunissen, E.L., Schneider, E. and Kauert, G., 2006. Cognition and motor control as a function of Δ^9 -THC concentration in serum and oral fluid: limits of impairment. *Drug and alcohol dependence*, 85(2), pp.114-122.
- Ramaekers J, Van Wel J, Spronk D, Toennes S, Kuypers K, Theunissen E, et al. 2016. Cannabis and tolerance: Acute drug impairment as a function of cannabis use history. *Scientific reports*. 2016; 6(1):26843. 21. Hartman RL, Huestis MA. Cannabis effects on driving skills. *Clinical chemistry*. 2013; 59(3):478-92.
- Robertson, M.B., Li, A., Yuan, Y., Jiang, A., Gjerde, H., Staples, J.A. and Brubacher, J.R., 2022. Correlation between oral fluid and blood THC concentration: a systematic review and discussion of policy implications. *Accident Analysis & Prevention*, 173, p.106694.
- Robinson, S.L. and Finucane, S.J., 2019, September. Key outcomes of functional benchmarking for waste rock landform closure at a Western Australian iron ore mine. In *Mine Closure 2019: Proceedings of the 13th International Conference on Mine Closure* (pp. 871-882). Australian Centre for Geomechanics.
- Rosendo, L.M., Rosado, T., Oliveira, P., Simão, A.Y., Margalho, C., Costa, S., Passarinha, L.A., Barroso, M. and Gallardo, E., 2022. The determination of cannabinoids in urine samples using microextraction by packed sorbent and gas chromatography-mass spectrometry. *Molecules*, 27(17), p.5503
- Rossow, I., Pape, H. and Torgersen, L., 2020.

Decline in adolescent drinking: Some possible explanations. *Drug and alcohol review*, 39(6), pp.721-728.

Rubin v National Director of Public Prosecution 2013 Case No: 7295 (WCC). Available from: <https://www.saflii.org/za/cases/ZACC/2018/30.html>. [Accessed: 20 January 2025]

Rubin, V. ed., 2011. *Cannabis and culture*. Walter de Gruyter. Pp. 107–109.

Rusinga, C., Klantschnig, G., Carrier, N., Howell, S., 2022. Cannabis policy changes in Africa are welcome. But small producers are the losers. Available from: <https://theconversation.com/cannabis-policy-changes-in-africa-are-welcome-but-small-producers-are-the-losers-179681#:~:text=These%20include%20Lesotho%2C%20Zimbabwe%2C%20South,about%20by%20two%20main%20factors>. [Last accessed: 30 January 2025].

Rutberg, S. & Bouikidis, C.D. 2018. 'Focusing on the Fundamentals: A Simplistic Differentiation Between Qualitative and Quantitative Research', *Nephrology Nursing Journal*, 45(2): 209-213.

Ryan, G.S. 2018. 'Introduction to positivism, interpretivism and critical theory', *Nurse Researcher* (2014+), 25(4): 14-20.

Sachse-Seeboth C, Pfeil J, Sehrt D, Meineke I, Tzvetkov M, Bruns E, et al. 2009. Interindividual variation in the pharmacokinetics of δ 9-tetrahydrocannabinol as related to genetic polymorphisms in cyp2c9. *Clinical Pharmacology & Therapeutics*. 2009; 85(3):273-6.

Sack, C., Simpson, C. and Pacheco, K., 2023, April. The emerging spectrum of respiratory diseases in the us cannabis industry. In *Seminars in Respiratory and Critical Care Medicine* (Vol. 44, No. 03, pp. 405-414). 333 Seventh Avenue, 18th Floor, New York, NY 10001, USA: Thieme Medical Publishers, Inc.

- Sagheddu C, Melis M. 2015. Individual differences and vulnerability to drug addiction: A focus on the endocannabinoid system. *CNS & Neurological Disorders-Drug Targets (Formerly Current Drug Targets-CNS & Neurological Disorders)*. 2015; 14(4):502-17.
- Saleska, J.L., Bryant, C., Kolobaric, A., D'Adamo, C.R., Colwell, C.S., Loewy, D., Chen, J. and Pauli, E.K., 2024. The safety and comparative effectiveness of non-psychoactive cannabinoid formulations for the improvement of sleep: A double-blinded, randomized controlled trial. *Journal of the American Nutrition Association*, 43(1), pp.1-11.
- Saravanakumar, P., Bisher, E.J., Aravinndh, R.A. and Kumar, K.S., 2021, April. Usage of fibre content in hemp as a material in building construction. In *IOP Conference Series: Materials Science and Engineering* (Vol. 1145, No. 1, p. 012057). IOP Publishing.
- SASOM alcohol and drug abuse in the workplace. SASOM guideline 9, 2011.
- Saunders, M., Lewis, P., & Thornhill, A. (2019). *Research Methods for Business Students* (pp. 257–259). Pearson Education, Limited, Harlow. Available from: ProQuest Ebook Central. [31 March 2022].
- Sempio, C., Huestis, M.A., Mikulich-Gilbertson, S.K., Klawitter, J., Christians, U. and Henthorn, T.K., 2020. Population pharmacokinetic modeling of plasma Δ^9 -tetrahydrocannabinol and an active and inactive metabolite following controlled smoked cannabis administration. *British journal of clinical pharmacology*, 86(3), pp.611-619.
- Schep, L.J., Slaughter, R.J., Glue, P. and Gee, P., 2020. The clinical toxicology of cannabis. *The New Zealand Medical Journal (Online)*, 133(1523), pp.96-103.
- Schulze, H., Schumacher, M., Urmeew, R., Alvarez, J., Bernhoft, I.M., de Gier, H.D.G., Hagenzieker, M., Houwing, S., Knoche, A., Pilgerstorfer, M. and Zlender, B., 2012. Driving under the influence of drugs, alcohol and medicines in Europe—findings from the DRUID project.

- Sharma P, Murthy P, Bharath MM. 2012. Chemistry, metabolism, and toxicology of cannabis: clinical implications. *Iran J Psychiatry*. 2012 Fall;7(4):149-56. PMID: 23408483; PMCID: PMC3570572.
- Smith, D.E., Marzilli, L. and Davidson, L.D., 2021. Strategies of Drug Prevention in the Workplace: An International Perspective of Drug Testing and Employee Assistance Programs. *Textbook of Addiction Treatment: International Perspectives*, pp.733-756.
- Smith, J.R., 2023. Ontario gold mine worker fired after testing positive for cannabis twice. Available from: <https://www.hrreporter.com/focus-areas/employment-law/ontario-gold-mine-worker-fired-after-testing-positive-for-cannabis-twice/377257>. [Accessed: 02 February 2025].
- Snyder, H., 2019. Literature review as a research methodology: An overview and guidelines. *Journal of business research*, 104, pp.333-339.
- South Africa. 1998. Employment Equity Act No. 55 of 1998. Pretoria. Government Printers.
- South Africa. 1996. Mine Health and Safety Act No. 29 of 1996. Pretoria. Government Printers.
- South Africa. 1996. National Road Traffic Act No. 93 of 1996. Pretoria. Government Printers.
- South Africa. 1996. The Constitution of the Republic of South Africa Act No. 108 of 1996. Pretoria. Government Printers.
- South Africa. 1995. Labor Relation Act No. 66 of 1995. Pretoria. Government Printers.
- South Africa. 1992. Drugs and Drug Trafficking Act No.140 of 1992. Pretoria. Government Printers.
- South Africa. 1992. Customs and Exercise Duty Act No. 27 of 1992. Pretoria. Government Printers.

South Africa. 1993. Occupational Health and Safety Act No. 85 of 1993. Pretoria. Government Printers.

South Africa. 1965. Medicine and Related Substances Act No. 101 of 1965. Pretoria. Government Printers.

South Africa. 1971. Abuse of Dependence-producing Substances and Rehabilitation Centres Act 41 of 1971. Pretoria. Government Printers.

South Africa. 1928. Medical Dental and Pharmacy Act No. 13 of 1928. Pretoria. Government Printers.

South African Breweries Ltd v Commission for Conciliation Mediation and Arbitration and Others (C 665/2011) [2012] ZALCCT 17. Available from: <https://www.saflii.org/za/cases/ZALCCT/2012/17.html>. [Last accessed: 12 January 2025].

South Africa. NDMP. 2024. National Drug Master Plan 4TH Edition 2019 TO 2024 South Africa Free of Substance Abuse.

Spindle, T.R., Martin, E.L., Grabenauer, M., Woodward, T., Milburn, M.A. and Vandrey, R., 2021. Assessment of cognitive and psychomotor impairment, subjective effects, and blood THC concentrations following acute administration of oral and vaporized cannabis. *Journal of psychopharmacology*, 35(7), pp.786-803.

Spindle TR, Cone EJ, Goffi E, Weerts EM, Mitchell JM, Winecker RE, et al. 2020. Pharmacodynamic effects of vaporized and oral cannabidiol (cbd) and vaporized cbd-dominant cannabis in infrequent cannabis users. *Drug and Alcohol Dependence*. 211:107937.

Steinmetz, Katy (April 20, 2017). "420 Day: Why There Are So Many Different Names for Weed". TIME. Archived from the original on August 12, 2018. Available from: [420 Day: Why There Are 1,000 Slang Terms for Marijuana | TIME](#). [Last accessed: 26 January 2025].

- Stringer RJ. 2022. Waiting for the Stop Sign to Turn Green: Contemporary Issues on Drug and Alcohol Impaired Driving Policy. *Am J Crim Justice*. 2022;47(4):735-748. doi: 10.1007/s12103-022-09705-5. Epub 2022 Nov 10. PMID: 36407840; PMCID: PMC9648432.
- Stumbrys, D. and Tamutienė, I., 2021. Alcohol intoxication incidence differences at companies in Lithuania. *Drug and alcohol review*, 40(7), pp.1165-1172.
- Suraev, A.S., Todd, L., Bowen, M.T., Allsop, D.J., McGregor, I.S., Ireland, C. and Lintzeris, N., 2017. An Australian nationwide survey on medicinal cannabis use for epilepsy: history of antiepileptic drug treatment predicts medicinal cannabis use. *Epilepsy & Behavior*, 70, pp.334-340.
- Suraev, A., Mills, L., Abelev, S.V., Arkell, T.R., Lintzeris, N. and McGregor, I.S., 2023. Medical Cannabis Use Patterns for Sleep Disorders in Australia: Results of the Cross-Sectional CAMS-20 Survey. *Nature and Science of Sleep*, pp.245-255.
- Svrakic, D. M., Lustman, P. J., Mallya, A., Lynn, T. A., Finney, R., & Svrakic, N. M. (2012). Legalisation, decriminalisation & medicinal use of cannabis: a scientific and public health perspective. *Missouri medicine*, 109(2), 90–98.
- Tanker Services (Pty) Ltd v Magudulela 1997 12 BLLR 1552 (LAC). Available from: <https://www.saflii.org/za/cases/ZALCCT/2011/11.pdf>. [Last accessed: 15 February 2025].
- Taskinen, S., Beck, O., Bosch, T., Brack, M., Carmichael, D., Fucci, N., George, C., Piper, M., Salomone, A., Schielen, W. and Steinmeyer, S., 2017. European guidelines for workplace drug testing in urine. *Drug testing and analysis*, 9(6), pp.853-865.
- Thorne S, New cannabis laws for South Africa – how much you can carry and what’s still illegal. Available from: <https://businesstech.co.za/news/government/755615/new-cannabis-laws-for-south-africa-how-much-you-can-carry-and-whats-still-illegal/>. [Last accessed: 05 February 2025].

- Tomaszewski, L. E., Zarestky, J., & Gonzalez, E. (2020). Planning qualitative research: Design and decision making for new researchers. *International Journal of Qualitative Methods*, 19, 1609406920967174
- Toney-Butler, T.J. and Siela, D., 2018. Recognizing alcohol and drug impairment in the workplace in Florida.
- Tosca Labs v CCMA 2012 33 ILJ 1738 (LC). Available from: <https://www.saflii.org/za/cases/ZALCPE/2011/23.html>. [Last accessed: 5 February 2025].
- United Nations. Office on drugs and crime. Executive summary: World drug report. 2023 [cited 2024 5 May 2024]. Available from: https://www.unodc.org/unodc/en/data-and-analysis/Exsum_wdr2023.html. [Last accessed: 13 February 2025].
- United States of America. 1996. Compassionate Use Act of 1996. Available from: https://leginfo.ca.gov/faces/codes_displaySection.xhtml?sectionNum=11362.5.&lawCode=HSC. [Last accessed: 20 February 2025].
- United States of America. 1970. Occupational Safety and Health Administration OHS Act of 1970. Available from: <https://www.osha.gov/laws-regs/oshact/toc>. [Last accessed: 02 February 2025].
- United States of America. 2005. Mine Safety Health Administration. Available from: <https://www.federalregister.gov/documents/2005/10/04/05-19846/use-of-or-impairment-from-alcohol-and-other-drugs-on-mine-property>. [Last accessed: 12 February 2025].
- Vandevenne M, Vandenbussche H, Verstraete A. 2020. Detection time of drugs of abuse in urine. *ActaClinBelg*. 2020;55:323–333.
- Van der Linden, T., Legrand, S.A., Silverans, P. and Verstraete, A.G., 2012. DUID: oral fluid and blood confirmation compared in Belgium. *Journal of analytical toxicology*, 36(6), pp.418-421.

- Van der Steur SJ, Batalla A, Bossong MG. 2020. Factors Moderating the Association between Cannabis Use and Psychosis Risk: A Systematic Review. *Brain Sciences*. 2020; 10(2):97.
- Vandrey, R., Herrmann, E.S., Mitchell, J.M., Bigelow, G.E., Flegel, R., LoDico, C. and Cone, E.J., 2017. Pharmacokinetic profile of oral cannabis in humans: blood and oral fluid disposition and relation to pharmacodynamic outcomes. *Journal of analytical toxicology*, 41(2), pp.83-99.
- Van Zyl, B., 2020. Cannabis in the workplace. *HR Future*, 2020(5), pp.46-47.
- Verstraete A, Knoche A, Jantos R, Skopp G, Gjerde H, Vindenes V et al. Driving under the Influence of Drugs, Alcohol and Medicines (DRUID): Per se limits - Methods of defining cut-off values for zero tolerance. 2011. Accessed May 20, 2024.
- Vozoris, N.T., Zhu, J., Ryan, C.M., Chow, C.W. and To, T., 2022. Cannabis use and risks of respiratory and all-cause morbidity and mortality: a population-based, data-linkage, cohort study. *BMJ Open Respiratory Research*, 9(1).
- Wade R. Biasutti, Kurt S. H. Leffers & Russell C. Callaghan (2020): Systematic Review of Cannabis Use and Risk of Occupational Injury, Substance Use & Misuse, DOI: 10.1080/10826084.2020.1759643
- Waetjen, T., 2022. Apartheid's 1971 Drug Law: Between Cannabis and Control in South Africa. *The Social History of Alcohol and Drugs*, 36(2), pp.164-200.
- Walia, P., Ghosh, A., Singh, S. and Dutta, A., 2022. Portable neuroimaging-guided noninvasive brain stimulation of the cortico-cerebello-thalamo-cortical loop—hypothesis and theory in cannabis use disorder. *Brain Sciences*, 12(4), p.445.
- Walsh, J.M., 2009. *A state-by-state analysis of laws dealing with driving under the influence of drugs* (No. DOT HS 811 236). United States. National Highway Traffic Safety Administration. Office of Behavioral Safety Research.

- Wang C, Pan R, Wan X, Tan Y, Xu L, McIntyre RS, et al. 2020. A longitudinal study on the mental health of general population during the covid-19 epidemic in china. *Brain, Behavior, and Immunity*. 2020; 87:40-8.
- Wang, G.S., Bourne, D.W., Klawitter, J., Sempio, C., Chapman, K., Knupp, K., Wempe, M.F., Borgelt, L., Christians, U., Leonard, J. and Heard, K., 2020. Disposition of oral cannabidiol-rich cannabis extracts in children with epilepsy. *Clinical Pharmacokinetics*, 59, pp.1005-1012.
- Wolch, S., Lindner, J., Demers, D. and Ratelband, B., 2018. Keep Calm and Understand Cannabis: What Employers in the Energy Sector Want to Know about Legalized Cannabis in the Workplace. *Alta. L. Rev.*, 56, p.337.
- Wolff K, Johnston A. Cannabis use: a perspective in relation to the proposed UK drug-driving legislation. *Drug Test Anal.* 2014; 6(1–2):143–54.
- Wolff, K., Brimblecombe, R., Forfar, J.C., Forrest, A.R., Gilvarry, E., Johnston, A., Morgan, J., Osselton, M.D., Read, L. and Taylor, D., 2013. Driving under the influence of drugs. *Report from the Expert Panel on Drug Driving (March 2013)*.
- Wong K, Brady JE, Li G. 2014. Establishing legal limits for driving under the influence of marijuana. *Inj Epidemiol.* 2014 Dec;1(1):26. doi: 10.1186/s40621-014-0026-z. Epub 2014 Oct 29. PMID: 27747660; PMCID: PMC5005632.
- World Health Organisation (WHO) [Internet]. Substance abuse. 2024. Available from: <https://www.afro.who.int/health-topics/substance-abuse>. [Last accessed: 6 February 2025].
- Yana, J.L., Lee, C., Eurich, D.T., Dyck, J.R., Hanlon, J.G. and Zongo, A., 2023. Risk of depressive disorders associated with medical cannabis authorisation: A propensity score matched cohort study. *Psychiatry research*, 320, p.115047.
- Zhu, Y., Gilman, J., Evins, A.E. and Sabuncu, M., 2019, October. Detecting cannabis-associated cognitive impairment using resting-state fNIRS. In *International Conference*

on Medical Image Computing and Computer-Assisted Intervention (pp. 146-154). Cham: Springer International Publishing.

Zimniewska, M., 2022. Hemp fibre properties and processing target textile: A review. *Materials*, 15(5), p.1901.