



The physical ability of women in mining: can they show muscle?

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Synopsis

Although women all over the world have been involved in mining activities for centuries, mining has always been considered a very masculine industry due to its heavily male-dominated workforce as well as the physicality of mining work. The mining industry has not been an obvious career choice and preferred place of employment for women; women were mainly employed in administrative and advisory positions. Until 1994, women were legislatively prohibited from being employed in underground operations in South Africa, but the Mines Health and Safety Act, No. 29 of 1996, removed these restrictions. In addition, new mining legislation (the Mineral and Petroleum Resources Development Act, No. 28 of 2002) and the accompanying Mining Charter make specific provisions for the inclusion of women in core mining activities and require 10% of core positions to be filled by women.

This article voices perceptions of the physical ability of women employed in core mining positions. Findings are drawn from empirical work undertaken at platinum, phosphate, and copper mines. Quantitative and qualitative research paradigms are used. It is evident that women find it extremely difficult to perform mine work that requires physical strength and stamina. Practical recommendations, informed by the literature review and empirical findings, are made with the objective of contributing to the sustainable deployment of women in the mining industry.

Keywords

core mining activities, mining industry, physical ability, sustainable deployment, women in mining.

Introduction

For many years, mining has been considered the foundation of the South African economy. Although the mining industry in South Africa is currently under considerable pressure and experiences various challenges, including escalating operational costs, electricity tariff increases, safety-related issues and associated production stoppages, poor productivity, labour unrest, and reduced demand both globally and domestically, it remains a key contributor to the national economy and development of the country (IDC, 2013, p. 9).

Until 1994, women were legislatively prohibited from meaningful participation in the mining industry and were denied access to skills and jobs, self-employment, and entrepreneurship. The newly elected democratic government in 1994 initiated substantial socio-political and economic transformation in South Africa. Nearly every sector in the country was transformed and re-shaped,

primarily through sector-specific legislation, but also through negotiations between government, industry, and labour unions to create and refine the so-called sector charters, which included the Mining Charter. The vision of the new regime, the African National Congress (ANC), was to 'transfer power to the people and transform society into a non-racial, non-sexist, united, democratic one, and change the manner in which wealth is shared, in order to benefit all the people' (ANC, 2007).

Transformation in the South African mining industry is governed by the provisions of the Mineral and Petroleum Resources Development Act, No. 28 of 2002 (RSA, 2002), which was promulgated and implemented on 1 May 2004, and the Broad-based Socio-economic Empowerment Charter for the South African Mining Industry (RSA, 2004) (hereinafter referred to as the Mining Charter), which was signed in October 2002 and formally published on 13 August 2004. The broad objectives of the Act and the accompanying Mining Charter (and the amended Charter) are to rectify previous inequalities and disadvantages in the mining sector and to ensure equity, accessibility, and sustainability in the industry. The Act and the Charter make specific provisions for the inclusion of women in core mining activities, in terms of which the industry was supposed to reach a quota of 10% women in core mining activities by 2009. Core mining activities include, among other activities, mining, metallurgy, engineering, and geology (Harmony Gold Mining Company, 2008, p. 32).

In 2009, the Department of Mineral Resources conducted a thorough impact assessment to determine the progress made

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against the Mining Charter objectives, as adopted in 2002, regarding transformation in the mining industry. This culminated in the Amendment of the Broad-based Socio-economic Empowerment Charter for the South African Mining and Minerals Industry (RSA, 2010), which was launched in September 2010. The Amendment of the Charter set further requirements in terms of employment equity targets. Mining companies are required to reach a target of 40% historically disadvantaged South African (HDSA) representation in core and critical skills by 2015 and, in addition, a 40% HDSA representation in junior management levels by 2011, middle management levels by 2013, and senior/executive management levels by 2015 (Cliffe Dekker Hofmeyr and Reid, 2010). The term HDSAs refers to black people (African, so-called Coloured people and Indians), women, and people with disabilities (Nel *et al.*, 2009, p. 79).

Although women all over the world have been involved in mining activities for centuries, mining is considered a very masculine industry due to its heavily male-dominated workforce as well as the physicality of mining work. Furthermore, the nature of working in mines, and specifically underground, is hazardous and extensive training is required (Wynn, 2001, p. 34). The mining industry has therefore not been an obvious career choice or preferred place of employment for women; women are mainly employed in administrative and advisory positions.

Although well-intended, the introduction of women into the very male, 'macho' mining environment created and still creates challenges, not only for managers but also for male co-workers and the newly employed female mineworkers. On the one hand, female employees need a sound level of overall fitness to complete everyday work as well as to achieve independence and credibility in the eyes of their co-workers. On the other hand, the mining industry is production-driven and employees are continually under pressure to reach production targets. Due to the physical differences between women and men, women often find it difficult to perform certain work activities and tasks and thus have a direct negative impact on production targets.

The purpose of this article is to voice perceptions of the physical ability of women employed in core mining positions. Findings are drawn from empirical studies undertaken at platinum, phosphate, and copper mines.

Research objectives

The specific objectives of this article are three-fold:

- To highlight issues regarding the physical ability of women employed in core mining positions according to the literature
- To determine issues regarding the physical ability of women employed in core mining positions according to the empirical findings
- To provide recommendations to address the issues identified so as to contribute to the sustainable deployment of women in the mining industry.

Research methodology

Research approach

A mixed-method research design was followed by applying both quantitative and qualitative research approaches.

Empirical context

Research participants

The research setting was limited to the following three mines: an underground copper mine, an underground platinum mine, and an opencast phosphate mine. The mines were selected on an availability basis (convenient sampling).

For the purpose of quantitative research, the study population consisted of an availability sample of management as well as male and female employees working in core mining activities at the three mines. In total, 156 responses were received – 68 from the copper mine, 38 from the platinum mine, and 50 from the phosphate mine.

Purposive or judgemental sampling was used to select participants for the qualitative research. In total, 12 individual interviews and 19 group interviews (69 participants) were conducted. The researcher aimed to gain information from various operations; the participants were therefore selected from various categories of employment and mining disciplines.

Measuring instruments

Quantitative data was collected by means of a structured questionnaire. Qualitative data was collected by means of individual interviews and group interviews. Both the individual interviews and the group interviews were semi-structured, as an interview guide was utilized. Data collected was audio- and video-recorded and written notes were taken.

Research process

The researcher formally requested permission from mine management to conduct research at the three mining companies. After permission was granted, a formal appointment was scheduled with mine management to explain the nature and extent of the research. In each research setting (mine), a contact person (the human resource officer targeted with managing women in mining issues) was allocated to the researcher to provide the necessary assistance and support during the research, which included distributing and collecting of the quantitative questionnaires, selecting appropriate participants for the individual and the group interviews, scheduling interviews, and organizing the underground field trip as well as visits to surface mining operations. Most of the individual and group interviews were scheduled between shifts in order not to interfere with the work responsibilities of the participants. Ethical considerations, such as voluntary participation, informed consent, privacy, anonymity, and confidentiality, as recommended by Babbie and Mouton (2011, p. 520), were taken into account while conducting the research. The research was also approved by the Committee of Advanced Degrees within the Focus Area Social Transformation of North-West University.

Data analysis

Quantitative data obtained through the questionnaires was analysed with the support and assistance of the Statistic Consultation Service of North-West University. The statistical software program SPSS 21.0 for Windows™ was used to analyse the data. Qualitative data obtained through the individual and group interviews and observations was analysed by means of conceptual (thematic) analysis.

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Reporting

Firstly, descriptive statistics and frequencies are presented, differentially in terms of the three mines included in the study. Descriptive statistics are reported per statement as mean values. The means can be interpreted as follows:

- Ratings of 2 and below indicate that the majority of the research participants disagreed or strongly disagreed with the indicator statement
- Ratings above 2 indicate that the majority of the research participants agreed or strongly agreed with the indicator statement. (The maximum response for each statement is 4.)

Secondly, the findings of a factor analysis, conducted to explore the factorial structure of the section, are reported and discussed. Thirdly, effect sizes were measured. Because an availability sample was used, p-values were not relevant and differences between means were examined for practical significance with effect sizes. Lastly, the findings of the qualitative enquiry are reported.

Limitations

A limitation to the study lies in the accessibility of the mining sector as a research setting. Past research has shown that it is sometimes extremely difficult to interview employees and representatives of mining companies and to get them to fill in questionnaires. It was not an easy task to gain access to the mining companies. Several visits and exchanges of correspondence took place before permission was granted for the research. In addition, the platinum mine experienced many difficulties as well as labour unrest during the period that the research was conducted. Because of this, several interviews with management were postponed and eventually cancelled. Despite numerous attempts by the researcher, no quantitative responses (questionnaires) were received from the management target group of the platinum mine. Furthermore, not all participants targeted for the individual and group interviews turned up for the meetings. Some of the participants could not stay for the full duration of the interviews due to work responsibilities and emergencies. Others were drained and tired after shift work and wanted to depart for home as soon as possible to get some rest and take care of their family responsibilities before the start of their next shift. The researcher made use of existing skills, knowledge, and networks to overcome some of these problems.

Literature review

Work in the mining sector is associated with difficult working conditions, and mining, especially underground, is considered one of the most physically demanding occupations (Schutte, 2011, p. 11). The nature of working in a mine, and in particular underground, is hazardous and extensive training is required. Many jobs also require a high degree of physical strength and endurance. Mine work includes, among other tasks, the ability to carry heavy objects and to work outside, underground, and in confined spaces, often in hot conditions for extended periods of time (Wynn, 2001, p. 34).

Some of the work tasks are difficult to perform due to the physical differences that exist between women and men (Wynn, 2001, p. 33). Due to women's smaller physical work capacity and physical strength, they may experience undue

physiological strain when performing prolonged and strenuous physically demanding tasks (Ashworth *et al.*, 2004, p. 34). Research conducted by Badenhurst (2012) revealed that 43% of new female recruits are not fit for physically demanding work in mining. The author attributes this mainly to the following:

- *Genetic predisposition of women.* Women have physiological disadvantages when performing physically demanding work
- *Workplace design.* The designs of equipment, machinery, and the workplace still cater for the male population
- *Lifestyle.* Women tend to have a less active lifestyle than their male counterparts.

A study conducted by Schutte *et al.* (2012, p. 3), which assessed workplace stress associated with routine mining activities, confirmed that women experience significantly more physiological strain than men when performing mining tasks.

Furthermore, much of the equipment used in South African mines is designed overseas for use by men, who tend to be significantly taller than the average South African woman (Schutte, cited in Campbell, 2007). The ergonomic features of such mining equipment do not provide for the physiological make-up of women. When mines started to recruit women, equipment was still only suitable for men, resulting in both women and men having to share such equipment. Body dimensions are an important concept that should be taken into consideration in the design of mining equipment as well as its efficient operation (Campbell, 2007).

Mine work also requires manual handling of equipment and tools. These are designed to accommodate the size and strength of men (Zungu, 2011). Although many tasks within the industry are being automated, the industry will essentially remain labour-orientated, as it will always include manual tasks (Wynn, 2001, p. 34). Such tasks can often cause back injuries and musculoskeletal disorders for workers (Badenhurst, 2009, p. 63). In general, the manual material-handling capabilities of women are substantially lower than those of men, attributed primarily to differences in muscle strength. On average, a woman's lifting strength is 60 to 70% of that of a man (Ashworth *et al.*, 2004, p. 34). According to Zungu (2011), there is a need to increase awareness and knowledge of the 'safe limits' for women for handling mining equipment and tools. Furthermore, women cannot use the same techniques as their male counterparts to lift and handle heavy objects and materials. Women's size and body build should be taken into consideration when appointing women in core positions (Zungu, 2011).

Gender differences also exist regarding the aerobic capacity of men and women. Aerobic capacity refers to the maximal oxygen uptake that provides a quantitative measure of a person's ability to sustain high-intensity physical work for longer than five minutes (Ashworth *et al.*, 2004, p. 34). The aerobic capacity of women is typically 15 to 30% below the values of their male counterparts. This means that women work closer to their aerobic capacity than men and are thus more likely to become fatigued. Fatigue is operationally defined as the 'reduced muscular ability to continue an existing effort' (Ashworth *et al.*, 2004, p. 34). High levels of fatigue can reduce performance and produc-



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tivity in the workplace and increase the risk of accidents and injuries occurring (Schutte, 2010, p. 54).

People working in mines, and in particular underground, are also exposed to extreme heat. The underground environment is dark and damp, and is characterized by an increase in temperature with depth (Singer, 2002, p. 1). In South African mines, work environments with a wet-bulb temperature higher than 27.4°C are considered to be hot and necessitate the introduction of practices to safeguard miners (Schutte, 2009). According to Ashworth *et al.* (2004, p. 35), all employees who work under 'conditions conducive to heat stroke should be screened for gross or permanent heat intolerance by means of the standard heat tolerance screening test procedure. Heat tolerance screening assesses whether an individual can withstand high temperatures while doing physically demanding work and is used to protect individuals against the negative consequences of heat exposure, such as heat stroke and heat-related diseases (Benya, 2009, p. 56). In the South African mining industry, heat tolerance screening consists of bench-stepping for 30 minutes in a climatic chamber at an external work rate of approximately 80 W in an environment with a dry-bulb temperature of 29.5°C and a wet-bulb temperature of 28.9°C. If the person's body temperature does not exceed a given value at the end of the test, the person is classified as potentially heat-tolerant, indicating that he or she is fit to undertake physically demanding work in a hot environment (with wet-bulb temperatures greater than 27.5°C) (Schutte, 2009, p. 3). Female employees are not given any privileges and must pass the same medical and screening tests as male employees (Singer, 2002, p. 2).

High occupational heat loads can lead to the following problems, among others: impaired work capacity; errors of judgement, with obvious implications for safety; lethargy and fatigue; and complications such as heat stress, which can lead to heat stroke, which is often fatal (Schutte, 2009, p. 1).

The following personal risk factors, among others, may reduce an individual's tolerance for heat stress: age, obesity, state of hydration, use of medication and drugs, gender, and acclimatization state (Zungu, 2011). Furthermore, gynaecological conditions and pregnancy can also affect the way in which women handle heat stress (Zungu, 2011).

According to Badenhorst (2009, p. 59), a female employee can do any job that she is qualified to do, provided that she meets the requirements inherent for the specific job. Furthermore, an employee should not be employed in a job or conduct tasks for which he or she is not medically fit or if he or she does not have the required physical and functional capabilities. The health and safety of the employee and co-workers should not be compromised (Badenhorst, 2009, p. 59). Therefore, Badenhorst (Badenhorst, 2009, p. 70) suggests that a programme be established to ensure that minimum medical requirements are met by employees, which include the establishment of minimum standards for fitness, comprising the following steps:

Step 1: Occupational health risk assessment

A clearly defined occupational health risk profile should be created for each occupation by identifying all relevant health hazards and the degree to which workers are exposed to these hazards.

Step 2: Man-job specification

The risks for each and every occupation should be documented, which should cover both the inherent requirements of the jobs and the expected hazard exposure(s).

Step 3: Setting standards for medical surveillance

A medical practitioner should set medical standards for each of these occupations based on the risk profiles. These should include standards for physical and functional ability required to perform certain jobs safely. A test battery to conduct and measure these abilities should be established.

From the above discussion, it is evident that various factors need to be considered when integrating women into the core business of mining in order not to compromise the health and safety of both female employees and their male colleagues.

Empirical findings and discussion

Physical ability of women employed in core mining activities

Statements were included to determine the perceptions of the three target groups, namely men and women employed in core mining positions and management, of the physical ability and capability of women employed in core mining positions. The descriptive statistics are presented in Table I for the three target groups at each of the three mines. To avoid duplication, the results are explained according to factor analysis. Factor analysis can be defined as a technique for identifying groups or clusters of variables (statements) (Field, 2005, p. 619).

Three factors (groups of variables) were extracted using Kaiser's criteria (Field, 2005, p. 652) that explain 39.92% of the total variance in the section on *Physical ability*. All statements have satisfactory factor loadings of above 0.3. Factor loadings represent the intercorrelation between the statements (variables). According to Field (2009, p. 644), an absolute value of 0.3 is regarded as important. Questions 1, 2, and 5 loaded on Factor 1 (*Capability*), questions 3 and 4 loaded on Factor 2 (*Effectively*), and Question 6 loaded on Factor 3 (*Differential*). It is evident from the quantitative results that the majority of the participants across all three mines agreed with the statements contained in the *Capability* (mean = 2.74), *Effectively* (mean = 2.77), and *Differential* (mean = 2.19) factors. On average, the perceptions with respect to Factor 1: *Capability* are that (i) women are physically less capable than men, (ii) some mining tasks can only be done by men, and (iii) temperatures in the workplace are regarded as a major problem for women. With respect to Factor 2: *Effectively*, (i) women have the physical ability to perform their daily tasks effectively, and (ii) they do not have a problem with working in confined spaces. With respect to Factor 3: *Differential*, it is perceived that (i) women should be treated differently to their male co-workers in the workplace. The *Capability* factor shows a Cronbach's alpha coefficient of 0.68, which could be regarded as an acceptable reliability. Cronbach's alpha is one method of estimating the reliability and internal consistency among the statements (Field, 2009, p. 675). According to Field (*op. cit.*, p. 668), the Cronbach's alpha value could realistically be below 0.7. The *Effectively* factor shows a Cronbach's alpha coefficient of 0.54, which

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Table I

Participants' perceptions regarding the physical ability of women working in core mining activities

Indicator statement		Copper mine			Phosphate mine			Platinum mine	
		Males in core	Females in core	Management	Males in core	Females in core	Management	Males in core	Females in core
1.	Women are physically less capable than men	3.50	2.56	3.19	3.13	2.26	2.92	3.25	2.50
2.	Some mining tasks can be done only by men	3.56	2.62	3.31	3.31	2.84	3.08	3.13	3.05
3.	I (women) have the physical ability to perform my (their) daily tasks effectively	2.63	3.41	2.75	2.59	3.30	2.67	3.07	3.32
4.	I (women) find it easy to work in confined spaces	2.31	2.53	2.00	2.00	2.39	2.50	2.67	2.63
5.	Temperatures in the workplace are regarded as a major problem for women	2.69	2.30	2.44	3.00	2.00	1.90	2.47	2.25
6.	Women should be treated differently than their male co-workers in the workplace	2.00	2.00	1.75	2.00	2.71	2.25	2.40	2.15

Mean scores of above 2 indicate that the majority of the research participants agreed or strongly agreed with the indicator statement.

Table II

Comparison of the three target groups of the different mines regarding physical ability

		Men		Women		Management		Effect sizes	
Factor	Mine	Mean	Standard deviation	Mean	Standard deviation	Mean deviation	Standard	Women vs Men	Women vs Management
Factor 1: Capability	Phosphate	3.18	0.64	2.39	0.70	2.68	0.37	1.12	0.41
	Copper	3.25	0.55	2.49	0.66	2.98	0.74	1.16	0.67
	Platinum	2.90	0.54	2.65	0.53			0.47	
Factor 2: Effectively	Phosphate	2.29	0.79	2.83	0.61	2.58	0.42	-0.67	-0.39
	Copper	2.47	0.64	2.99	0.63	2.38	0.53	-0.80	-0.96
	Platinum	2.81	0.57	3.02	0.58			-0.36	
Factor 3: Differential	Phosphate	2.00	1.12	2.71	0.96	2.25	0.62	-0.64	-0.49
	Copper	2.00	0.97	2.00	0.80	1.75	0.68	0.00	-0.31
	Platinum	2.38	1.20	2.16	0.90			0.18	

(a) Small effect: $d = 0.2$, (b) medium effect: $d = 0.5$, and (c) large effect: $d = 0.8$

could be regarded as having relatively low reliability. Factor 3 consists of one item only, therefore Cronbach's alpha is not applicable.

From Table II, it follows that the effect sizes for the Capability factor show a medium and large effect, indicating that, on average, the participants from the male and management target groups are more in agreement with the indicator statements contained in the *Capability* factor than the female target group themselves. The effect sizes for the *Effectively* factor indicate that the participants from the female target groups of the phosphate and copper mines are more in agreement with the indicator statements contained in the factor than the participants from the male and management target groups at these mines. A medium effect is evident from the effect sizes of the phosphate mine for the *Differential* factor, indicating that, on average, the female participants from the phosphate mine feel that they should be treated differently from their male co-workers in the workplace, while this view is not supported by the research participants in the male and management target groups.

Perceptions of women's performance and position in core mining activities

Questions were also included in the questionnaire to determine whether women feel confident in performing core mining activities and to verify perceptions of male co-workers and management regarding women's confidence in performing core mining activities.

Figure 1 shows that the majority of the women in all three mines (copper mine: 67.9%; phosphate mine: 57.9%; platinum mine: 68.4%) feel confident in performing their respective work activities. Only a few participants (copper mine: 3.6%; phosphate mine: 15.8%; platinum mine: 15.8%) indicated that they do not feel confident at all.

The male and management participants were asked to give their opinions on whether women feel confident in performing the following core activities: driving a locomotive, driving a winding engine, operating a conveyer belt, using heavy and/or vibrating power tools, driving a winch, and operating a shift. The results are presented in Table III.

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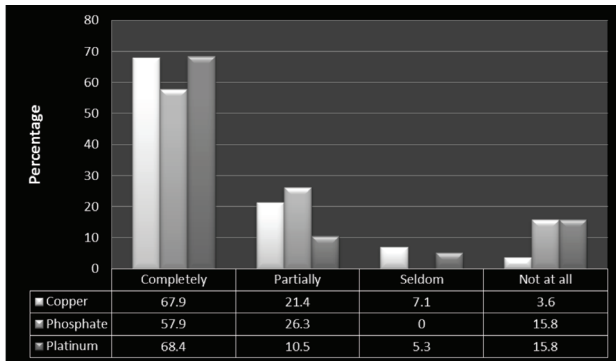


Figure 1 – Female participants' perceptions regarding their confidence to perform work activities

The results reported in Table III show that the majority of the participants in the male and management target groups thought that women are confident in performing all mentioned activities, with the exception of the use of heavy and/or vibrating power tools. This view is supported by the findings from the literature review as well as the qualitative enquiry.

Perceptions and major concerns regarding the physical ability and capability of women employed in core mining positions

Equipment, tools, and work units

The data obtained from the qualitative enquiry revealed that women are employed in all sections at the mines, underground as well as on the surface, and fill positions such as engineer, geologist, electrician, artisan, fitter, boilermaker, and operator of heavy machinery. They are also involved in technical and mechanical mining operations. However, pregnant women are not allowed to enter work areas in which they could be exposed to radiation. The participants also indicated that no mining equipment and tools are banned from use by women, with the exception of load haul dump (LHD) machines. When female employees initially operated these machines, many complaints were lodged due to the vibrations caused. The female participants indicated that vibration caused by the LHD machines had a negative impact on their health and interfered with their menstrual cycles. As a result, women are no longer allowed to operate LHD equipment.

Although female employees are employed as rock drill and winch operators, the female participants reported that these types of equipment are too difficult for women to operate because they are too heavy. Furthermore, the participants from the management target group at the phosphate mine indicated that they have experienced problems when women operated rubber dozers, as noted in the following comment:

What happens, because that dozer drills the whole time, it interferes with females' monthly period ... There are complaints, they go to medical doctors, the doctors have picked it up, it seriously disturbed them, it makes them seriously sick, you can check at a couple of mines we have done our homework, they experience the same problem. They rather put them in the track dozer and not in the rubber dozer, because the rubber dozer is the one that vibrates the whole time. I have had four cases of ladies who had medical problems with regard to that and we had to move them around to the track dozers instead of the rubber dozers.

Perceptions and major concerns of management

From the interviews and focus group discussions held with the participants in management positions, it became clear that although job reservation does not exist and women are employed in all sections at the mines, women do not have the physical strength and ability to be employed in all core mining positions. According to the participants, it is important to consider job specifications and requirements when appointing women in positions that require physical strength. Women are often appointed in core mining positions without having the physical ability to cope with the requirements of these positions; male employees have to assist and support their female colleagues to do their jobs properly. This often leads to frustration on the side of male co-workers and contributes to a negative attitude towards women in mining. Male co-workers are often unwilling to assist their female colleagues because they feel that since women appointed in these positions receive equal salaries, they should do their jobs on their own. The following quotations provide an indication of some participants' opinions with regard to the physical ability of women employed in core mining positions:

You know I think it's about the company's recruitment and selection procedures and plans. Every human being has his own strengths and weaknesses. There are women

Table III

Male and management participants' perceptions regarding women's confidence in performing core mining activities

Indicator statement		Male in core			Management	
Do you think women are confident in performing the following activities?		Copper mine	Phosphate mine	Platinum mine	Copper mine	Phosphate mine
1.	Driving a locomotive	3.00	3.12	3.43	3.07	3.08
2.	Driving a winding engine	3.00	2.54	2.80	2.93	3.22
3.	Operating a conveyer belt	3.06	3.47	3.21	2.94	3.08
4.	Using heavy and/or vibrating power tools	1.69	2.23	1.60	1.94	2.45
5.	Driving a winch	2.75	3.00	1.87	2.81	3.00
6.	Operating a shift	3.06	3.36	3.19	3.00	3.00

Mean scores of above 2 indicate that the majority of the research participants agreed or strongly agreed with the indicator statement.

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that are stronger than men and there are men stronger than women. It is important when a position/job becomes available to look at the requirements of this position/job and then evaluate how you will determine whether candidates are physically strong enough to fill this position. In the past, we have often made mistakes with the appointment of women by not looking at the requirements of the position/job. We appointed thin, fragile women who could not cope with the requirements of the position/job. The male colleagues then often have to assist women who are not physically strong enough to do their jobs and they then become easily frustrated and annoyed with their female colleague.

It depends on the type of work they do. For example, women find it difficult to do mechanical type of work that requires physical strength. On the other hand, women perform well if they do work that requires little or no physical hard labour. But as soon as they start to do heavy work or work that need some physical strength or power, they cannot do it.

Perceptions and major concerns of male co-workers

Data obtained from male employees working in core mining positions revealed frustrations regarding the physical ability of women, production targets, crisis situations, attitudes of women, and confrontations with husbands/boyfriends.

The male participants clearly indicated that women often lack the physical strength to perform certain work activities. It was noted that women are able to perform light duties, but experience difficulties when operating heavy machinery and lifting heavy objects. Furthermore, it was indicated that women often do not have the stamina to perform certain work activities. According to the male participants, women's bodies are not made to perform hard physical mine work. Male co-workers often have to support and assist female employees when they do not have the physical strength to perform their work. Some male participants said that they are willing to assist women who are willing to work, but they are negative towards women who do not show a willingness to do the work for which they were appointed. Others get agitated when they have to assist women or do/complete their work for them. The following comments illustrate these points:

Some work women can do, and some not. Some heavy objects they cannot lift. They find it difficult to work in confined spaces. It is not all the women who can use the safety harness to work at heights. Some of the duties at my section, I just do it by myself, because I see that they find it tough.

When [it comes] to physical ability, I don't think they have that power to work as a man, because most of the [work is] underground. You need physical strength, so if you don't have that strength you won't make it to do that job correctly, because some of them you can see that she is trying, but she doesn't have the power to do that.

From my experience: When the work gets tough, the woman move to one side and let the men do the work.

Men do get agitated when they have to assist women. We have to speak to them and convince them that these are women.

The mining industry is production-driven and highly focused on reaching production targets. According to the male participants, the inclusion of women in a mining team has a severe impact on productivity, as they feel that women are not physically able and capable of pulling their weight in the team and they often lack physical strength and stamina. The male participants reported that they prefer to work with an all-male team due to the fact that mine work should always be done against time in order to reach production targets. If certain tasks are not performed well, delays result. Furthermore, pregnancy can affect the productivity of the team. When pregnant, women are not allowed to perform certain work activities; they are employed elsewhere in the company. The company does not always appoint another team member in the place of the pregnant woman, and the team thus has to rely on fewer workers to complete the same tasks. This also has a severe impact on reaching production targets. These points are confirmed by the following responses:

Last week I was talking to this other supervisor in the plant. He told me that in his shift, he prefers to have a male than to have a female, because he knows when he has 10 males he can do his job quicker. If he has nine men and only one woman he knows there will be some delays, because there are some jobs that a woman cannot do.

You know sometimes the reason why men help women to do their job, it's because of time or because of the work we are doing. Maybe it's too much for us and we must knock off, maybe at 14:00. So women are not so much strong, so we must make it snappy. So they must sit down there so that we can do it.

Due to the fact that mine work is associated with a high risk of accidents, male employees often prefer to work with men because they feel that men can act faster in crisis situations, as was pointed out by one of the participants:

Women are not faster than men. For example, when there is a fire on top of the plant, something is burning, the woman cannot pick up the fire extinguisher and rush to the fire, but the man can easily do that.

The participants from the platinum mine indicated that male co-workers often experience problems with women's attitudes. Although they acknowledge that some women are willing and capable to do the work for which they are appointed, others want to be 'treated like ladies' in the workplace. The following quotations provide an indication of the participants' opinions in this regard:

Women are always complaining. They want us to treat them special, but they don't want to do the work. They complain that the work it is too heavy. And underground, there is no easy job there. Everything is very hard.

Some women they want to be treated like ladies; [...] we don't have such a kind of chance to treat them like ladies, because we are always in a hurry. Underground everything is done against time and against production – the mining company wants production the whole time. The ladies they want to be treated like glass, eggs.

The male participants from the platinum mine reported that they are often confronted by husbands and boyfriends when their wives and girlfriends are given jobs that require physical strength, as noted in the comment below:

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There was this other guy at the station. He came to me straight and asked me why do I give his girlfriend a hard job. So do you see what is this thing causing? Men are complaining to us or maybe they want to fight us.

Perceptions and major concerns of women employed in core mining positions

Although the female participants indicated that they have the physical ability to do their jobs well, they admitted that the work is tough and not easy to perform, especially underground. It was also reported that, on average, the women are willing and able to perform their jobs well; however, the women admitted that they do not always have the physical strength, power and stamina required for specific positions. They reported that some male co-workers are willing to assist them, while others are unwilling and would rather watch them suffer than be of assistance. Women want to prove themselves and often neglect their bodies to do their jobs well. The following quotes provide indications of the female participants' opinions regarding the physical ability of women employed in core mining positions and the constraints experienced:

I don't have the steam to work at the position that I am working at. I am not strong enough. The job of mine is too hard. We are sweating underground.

The loco is like a train, nè? It's hard to operate. The steering wheel and everything is hard. The brakes. And to be on it every day, yô, it is hard. When you go on period you have some pains. Your back it pains. And that thing, it vibrates. I'm on it eight hours every day.

Yes, I have the physical ability to do my work on my own. It's just, I have to make a plan to go out on my own. I find that some of the male workers are using power to do the job and I find that I have to come with a plan to make it simple.

The empirical results confirm the findings of the literature review, which suggest that female mineworkers are at a disadvantage in terms of ability to perform mine work that requires physical strength and stamina. They experience physiological strain when performing prolonged and strenuous physically demanding tasks.

Conclusion and recommendations

It is evident from the literature review, and confirmed by the empirical findings, that various factors (such as physical strength and fitness, heat tolerance, body dimensions, and ergonomic features of mining equipment) need to be considered when appointing women in core mining positions. Although physical fitness tests and heat tolerance screening are carried out prior to the appointment of women in core mining positions, and regardless of the kind of mining (underground or opencast), the empirical findings confirm that women are still appointed in positions entailing work that they find extremely difficult to perform, such as the operating of heavy machinery (LHD equipment, rubber dozers, rock drills, and winches), or performing mine work that requires physical strength and stamina and using heavy and/or vibrating power tools. Furthermore, due to women's inability to perform mine work that requires physical strength and stamina, management and male co-workers experience unique frustrations and challenges.

In light of the above, the following recommendations, informed by the literature review and the empirical findings, are made to contribute to the sustainable deployment of women in the mining sector:

- There is an urgent need to conduct research on and identify specific issues that could cause physiological strain to the female mineworker in order not to compromise their health and safety. Creating awareness of these issues is of utmost importance
- Mining companies should review their recruitment and selection procedures to maximize the fit between female mineworkers and their specific positions in the mines
- An employee should not be appointed in a position or conduct tasks for which he or she is not medically fit or does not have the physical and functional capabilities
- An employee should be appointed in a position only if he or she meets the requirements for that specific job
- Regular training courses should be conducted to educate women on correct biomechanics when operating heavy machinery and using heavy and/or vibrating power tools
- Fitness and conditioning programmes should be developed and established to assist women in handling their everyday work activities
- Regular diversity training and workshops focusing on aspects regarding the female miner, such as the physical strength and stamina of women, and physiological aspects related to the female body, such as menstruation, pregnancy, and birth, should be presented to male and female employees to foster a work environment in which differences (in terms of gender) are respected.

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