

# Perceived neighborhood safety and exercise behavior among community dwellers in Gauteng, South Africa

Zhifei He, PhD<sup>a</sup>, Bishwajit Ghose, PhD<sup>b</sup>, Sanni Yaya, PhD<sup>c</sup>, Zhaohui Cheng, PhD<sup>d</sup>, Yan Zhou, PhD<sup>a,\*</sup> 

## Abstract

Maintaining a physically active life is an important determinant of overall health and psychosocial wellbeing among adults. Physical exercise behavior can be influenced by various social and environmental circumstances including neighborhood safety. Using data from South Africa Quality of life Survey 2015/16, this study aimed to assess the hypothesis that lack of perceived neighborhood safety (PNS) can reduce the likelihood of engaging in physical exercise (PE). The participants were 30,002 men and women aged 18 years and above. The association between self-reported PE behavior and neighborhood safety were assessed by multivariable regression method while adjusting for potentially confounding factors. Less than a quarter (23.41%) of the participants reported taking exercise on daily basis whereas 27.90% reported never taking any. Respectively 6.0% and 38.1% of the participants reported feeling very unsafe walking in the neighborhood during day and night. In regression analysis, both the pooled and stratified models indicated that lack of PNS was inversely associated with regular PE. Lack of PNS (bit unsafe) during day was associated with lower odds of PE both among men (OR=0.776,  $P < .001$ ) and women (OR=0.874,  $P < .001$ ). The negative association between lack of PNS and PE during day was significant among those living with disability (OR=0.758,  $P < .001$ ). Further analysis showed that the negative association between lack of PNS with regular PE during day was significant in Johannesburg (OR=0.800,  $P < .001$ ), Tshwane (OR=0.735,  $P < .001$ ) and Emfuleni (OR=0.619,  $P < .001$ ) only, while that during night was significant in Johannesburg (OR=0.737,  $P < .001$ ), Ekurhuleni (OR=0.673,  $P < .001$ ), Emfuleni (OR=0.418,  $P < .001$ ), Lesedi (OR=0.385,  $P < .001$ ), Mogale City (OR=0.693,  $P < .001$ ), and Randfontein (OR=0.565,  $P < .001$ ). Overall, the findings highlight a significantly inverse association between lack of PNS and PE behavior. In light of the current findings, it is recommended that PE promotion programs pay special attention on population living in the neighborhoods fraught with crime concerns.

**Abbreviations:** CAPI = computer aided personal interviewing, GCRO = Gauteng City Regional Observatory, ISCOLE = lifestyle and the environment, PURE = prospective urban rural epidemiology.

**Keywords:** exercise behavior, gauteng, perceived neighborhood safety, South Africa

Editor: Antonino Bianco.

The study was based on analysis of anonymized secondary data available in the public domain, therefore no additional approval was necessary. This study was supported by National Social Science Foundation of China (20XGL027) (2013-GM-048), Chongqing Social Science Planning Project (No. 2019QNGL33) and 2019 Southwest University of Political Science and Law Project (No.2019XZQN-30).

The authors declare no conflict of interest.

The datasets generated during and/or analyzed during the current study are available from the corresponding author on reasonable request.

<sup>a</sup> School of Politics and Public Administration, Southwest University of Political Science and Law, Chongqing, <sup>b</sup> Faculty of Social Sciences, <sup>c</sup> Faculty of Social Sciences, School of International Development and Global Studies, University of Ottawa, 120 University Private, Ottawa, ON, Canada, <sup>d</sup> Chongqing Health Information Center, Chongqing, China.

\* Correspondence: Yan Zhou, School of Politics and Public Administration, Southwest University of Political Science and Law, Chongqing 401120, China (e-mail: mszhouyan023@163.com).

Copyright © 2020 the Author(s). Published by Wolters Kluwer Health, Inc. This is an open access article distributed under the terms of the Creative Commons Attribution-Non Commercial License 4.0 (CCBY-NC), where it is permissible to download, share, remix, transform, and buildup the work provided it is properly cited. The work cannot be used commercially without permission from the journal.

How to cite this article: He Z, Ghose B, Yaya S, Cheng Z, Zhou Y. Perceived neighborhood safety and exercise behavior among community dwellers in Gauteng, South Africa. *Medicine* 2020;99:51(e23552).

Received: 15 June 2020 / Received in final form: 9 October 2020 / Accepted: 2 November 2020

<http://dx.doi.org/10.1097/MD.00000000000023552>

## 1. Introduction

South Africa has one the highest crime rates in the world which is regarded as a major roadblock for promotion of public health and for socioeconomic development at large.<sup>[1]</sup> Controlling crime rates has been one of the main priorities for government spending, nonetheless the situation has been worsening and according to some estimates, all types of crimes have increased since 2013.<sup>[1]</sup> The consequences of crime and violence can be broad and affect various aspects of physical,<sup>[2,3]</sup> and mental health<sup>[4]</sup> and social life.<sup>[5,6]</sup> In addition to direct loss of life and disability, crime and violence can give rise to a situation characterized by general public fear<sup>[7]</sup> and erosion of social capital and impact key areas of social lives e.g. community cohesion, trust and sense of belonging.<sup>[8,9]</sup> Reduced social capital in turn can affect health<sup>[10,11]</sup> and health related behavior, especially ones that involve outdoor activities such as sports, traveling and physical exercise (PE).<sup>[12,13]</sup>

The current literature suggests that engaging in PE has numerous health and psychosocial benefits that are necessary for maintaining a productive and healthy life.<sup>[14,15]</sup> There has been a growing body of literature on the factors that predict engagement in health promoting physical activities such as active and leisure time PE. The exercise behavior research has mostly been dominated by the environmental, demographic and socioeconomic<sup>[15–17]</sup> domains which has greatly contributed to the understanding of the inequalities and challenges associated

**Table 1****Sample details (n=30,002).**

Variables	Total Sample (%)	Everyday (23.41%)	Few times a week (23.46%)	Few times a month (12.48%)	Hardly ever (12.77%)	Never (27.90%)	P value	
Age								
18–19	4.0	5.0	4.2	4.1	2.9	3.5	<.001	
20–24	11.6	12.6	12.9	11.2	9.5	10.8		
25–29	14.0	15.0	14.7	13.3	12.6	13.7		
30–34	13.6	13.8	14.0	13.1	13.6	13.5		
35–39	12.9	12.5	13.2	14.1	12.9	12.3		
40–44	10.1	9.7	9.7	10.6	10.3	10.4		
45–49	8.7	8.1	9.0	10.2	9.8	7.8		
50–54	6.9	6.4	6.5	6.5	7.5	7.6		
55–59	5.9	6.0	5.4	5.6	6.4	6.1		
60–64	4.4	4.1	3.7	4.2	5.5	4.7		
65+	7.9	6.7	6.7	7.1	9.1	9.7		
Sex								
Male	46.5	51.2	50.8	50.4	43.2	38.7	.031	
Female	53.5	48.8	49.2	49.6	56.8	61.3		
Population subgroup								
African	80.5	76.5	75.5	75.7	81.1	90.0	<.001	
Coloured	3.8	4.2	4.6	4.2	3.6	2.7		
Indian/Asian	2.1	2.2	2.6	3.1	2.5	1.1		
White	13.1	16.7	16.9	16.5	12.5	5.7		
Other	0.4	0.3	0.4	0.5	0.4	0.4		
Region								
Johannesburg	32.7	34.8	36.3	36.8	32.2	26.4	<.001	
Tshwane	24.1	20.9	24.6	23.4	31.7	23.3		
Ekurhuleni	24.2	26.1	19.7	24.9	22.6	27.0		
Emfuleni	5.6	7.5	6.6	5.3	4.2	4.2		
Lesedi	1.3	1.3	2.0	1.3	1.2	0.9		
Midvaal	1.5	2.4	1.5	1.2	1.4	0.8		
Merafong	3.0	2.3	2.7	1.8	1.8	4.9		
Mogale City	3.5	2.0	3.5	3.0	2.6	5.5		
Randfontein	2.3	2.0	1.9	0.9	1.0	4.1		
Westonaria	1.7	0.8	1.3	1.4	1.3	3.0		
Education								
No Education	1.6	1.1	1.1	1.3	1.3	2.9		<.001
Primary only	11.0	8.2	8.0	8.4	12.1	16.5		
Secondary incomplete	29.9	27.5	25.7	24.8	30.3	37.5		
Matric	33.0	35.1	33.9	34.3	32.9	29.9		
More	22.5	26.4	29.1	29.2	20.1	11.8		
Unspecified	2.0	1.7	2.2	2.0	3.3	1.4		
Employment								
Employed	48.6	53.4	53.1	52.0	47.0	39.9	<.001	
Unemployed	51.4	46.6	46.9	48.0	53.0	60.1		
Subjective health								
Excellent	34.1	45.2	34.3	32.7	23.1	30.3	<.001	
Good	57.5	48.9	59.0	59.7	66.3	58.4		
Poor	7.4	5.2	5.9	6.7	9.4	9.7		
Very Poor	1.0	0.7	0.7	0.9	1.3	1.5		
Has any disability								
Yes	5.8	5.1	5.4	4.9	6.4	6.7	.002	
No	94.2	94.9	94.6	95.1	93.6	93.3		
Perceived safety during night								
Very safe	30.7	35.9	32.0	27.8	23.3	29.7	<.001	
Fairly safe	42.5	40.6	43.7	44.8	47.5	39.8		
Neither safe or unsafe	8.5	7.6	9.1	10.4	9.8	7.3		
Bit unsafe	12.3	10.4	10.2	12.0	13.1	15.5		
Very unsafe	6.0	5.5	5.0	5.0	6.3	7.7		
Perceived safety during night								
Very safe	7.1	22.2	22.9	24.8	27.6	23.9	<.001	
Fairly safe	20.0	40.2	34.0	30.7	33.1	45.2		
Neither safe or unsafe	10.9	9.4	11.2	14.9	13.3	9.2		
Bit unsafe	23.9	9.7	7.8	6.2	4.3	6.0		
Very unsafe	38.1	18.5	24.1	23.4	21.6	15.7		

N.B. P values are from chi-squared tests.

with PE at population level. In contrast to these direct and micro-level factors, researchers are showing increasing interest in understanding whether the psycho-environmental issues such as PNS influence health and lifestyle behavior including PE. Existing literature indicates an inverse association between PNS and subjective measures of physical, general, and mental health.<sup>[18]</sup> Less is known, however, on the relationship between perceived safety and exercise behavior, especially in low-middle income settings.

Previous studies have demonstrated that factors such as health knowledge, self-determination, perceived need and availability of the physical infrastructure play a crucial role in engaging in PE.<sup>[19,20]</sup> However, it is arguable that a sense of fear and victimization can suppress the perceived needs and drivers of PE even when the facilities are available. Fear for crime can deter individuals from going outside for recreational purposes and taking physical activities such as walking and jogging. A recently published study based on National Youth Lifestyle Survey (2008) on young (age 12–22 years old) South African sample reported a significant association between PNS and participation in social

activities.<sup>[1]</sup> Also, South Africa has one of the highest crime rates globally.<sup>[21]</sup> With the wider availability of social and mass media technologies, transmission of information regarding the crime events have become instantaneous which not only allows the population to take precaution from potential danger, but have also contributed to the growth and spread of social mistrust and perceived lack of safety within communities.<sup>[22,23]</sup> From this perspective, perceived lack of neighborhood safety can also have potentially negative effects on health and social behavior as actual crime and violence.

Research evidence on these less understood factors are necessary to design policy and intervention to promote PE. To date, no systematic research has been conducted on PE from this perspective on a large-scale survey in South Africa. The potential reasons are apparent lack of recognition of the matter and/or of quality data. In this study, we aimed to address this research gap by using open-access data from the Quality of Life Survey (2015–2016). We hypothesize that PNS will be associated with lower likelihood of taking regular PE, and the likelihood will be more pronounced among women and among those living with



**Figure 1.** Proportions (%) of participants reporting lack of safety stratified by age groups. Shows the proportion of participants reporting lack of neighborhood safety stratified by age and sex groups. The figure shows that those aged between 25 and 29 had the highest percentage of reporting lack of safety during day and night. For both day and night, the percentage dropped for increasing age groups to be the lowest among those aged 60 to 64 years and then increased again for the age group of 65+ years, indicating that elderly people might be more vulnerable to lack of neighborhood safety compared with middle aged population (50–64 years). The distribution of perceived lack of safety was significantly different across the age groups ( $P < .001$ ).

disability. The Quality of Life Survey questionnaire included a variety of indicators relevant to environment, health and living standards, including PNS among men and women aged 18 years and above. It is worthy of note that the survey was not primarily designed to assess the proposed hypothesis, wherefore there is a lack of certain variables that are well-known predictors of PE among adult population. Nonetheless, the findings are expected to contribute to the literature and provide insights for research and policy dialogues.

## 2. Materials and methods

### 2.1. Study sample and data collection

The Quality of Life survey 2015–2016 covered the whole of Gauteng and selected areas from the four neighbouring provinces of Free State, North West, Limpopo and Mpumalanga. Data collection started on 2015-07-06 and ended on 2016-05-17 and involved 30002 interviews. Fieldwork involved face-to-face interviews using Computer Aided Personal Interviewing (CAPI) methods. Each interview lasted for about 45 minutes on average. The questionnaire for this survey was designed by the Gauteng City Regional Observatory (GCRO). The questionnaire included

closed-ended questions with a few open-ended ones surrounding topics such as demographics, health, living environment, access and satisfaction with public services, employment, and crime and safety. More details of the survey are available on the methods report: Gauteng City-Region Observatory.<sup>[24]</sup>

### 2.2. Measures

The outcome variable was engaging in physical activity and was assessed by the question: *How frequently do you exercise (e.g., walk, run, gym)?* The options for answer were: *Everyday/ Few times a week/ Few times a month/ Hardly ever/ Never*. To facilitate the analysis, this was recategorized as regular PE (*Everyday/ Few times a week*) and irregular/no PE (*Few times a month/ Hardly ever/ Never*).<sup>[25]</sup>

The explanatory variable of interest was PNS. This was assessed by the questions: 1) *How safe do you feel walking in your area during the day?* And 2) *How safe do you feel walking in your area after dark?* The options for answering these questions were: *Very safe/ Fairly safe/ Neither safe or unsafe/ Bit unsafe/ Very unsafe*.

To adjust the analysis for potentially confounding factors, the following variables were deemed relevant in light of previous



**Figure 2.** Proportions (%) of participants reporting lack of safety stratified by disability status. Summarizes the proportion of participants reporting lack of neighborhood safety according to presence or absence of disability. It indicates that the percentage of reporting lack of safety was relative lower among those who had no/sight disability, but higher among those with hearing, communication and physical disability. The distribution of perceived lack of safety was significantly different among those who reported disability and those who did not ( $P < .001$ ).

studies were included in the multivariate analysis: Age (18–19/ 20–24/ 25–29/ 30–34/ 35–39/ 40–44/ 45–49/ 50–54/ 55–59/ 60–64/ 65+); Sex (Male/ Female); Population subgroup (African/ Coloured Indian/Asian/ White/ Other); Region Johannesburg/ Tshwane/ Ekurhuleni/ Emfuleni/ Lesedi/ Midvaal/ Merafong/ Mogale City/ Randfontein/ Westonaria); Education (No Education, Primary only/ Secondary incomplete/ Matric/ More/ Unspecified); Employment status (Employed/ Unemployed); Subjective health (Excellent/ Good/ Poor/ Very Poor); Has any disability (Yes No). Types of self-reported disability included: visual, hearing, communication and physical.

**2.3. Statistical analysis**

All analyses were performed using STATA 14. Sample characteristics were presented using percentages using cross-tabulation. The sub-group percentages of perceived PNS for age were shown as bar charts. Confounder-adjusted association between PNS and PE was measured using binary logistic regression methods and presented as odds ratio plots with 95% confidence intervals. After the pooled analysis, the regression model was further stratified first by sex, and then by disability (has ability vs no disability). Lastly, we performed the same models for each of the 11 regions to assess the sensitivity of the associations. *P* value

of  $< .05$  was considered statistically significant for all associations.

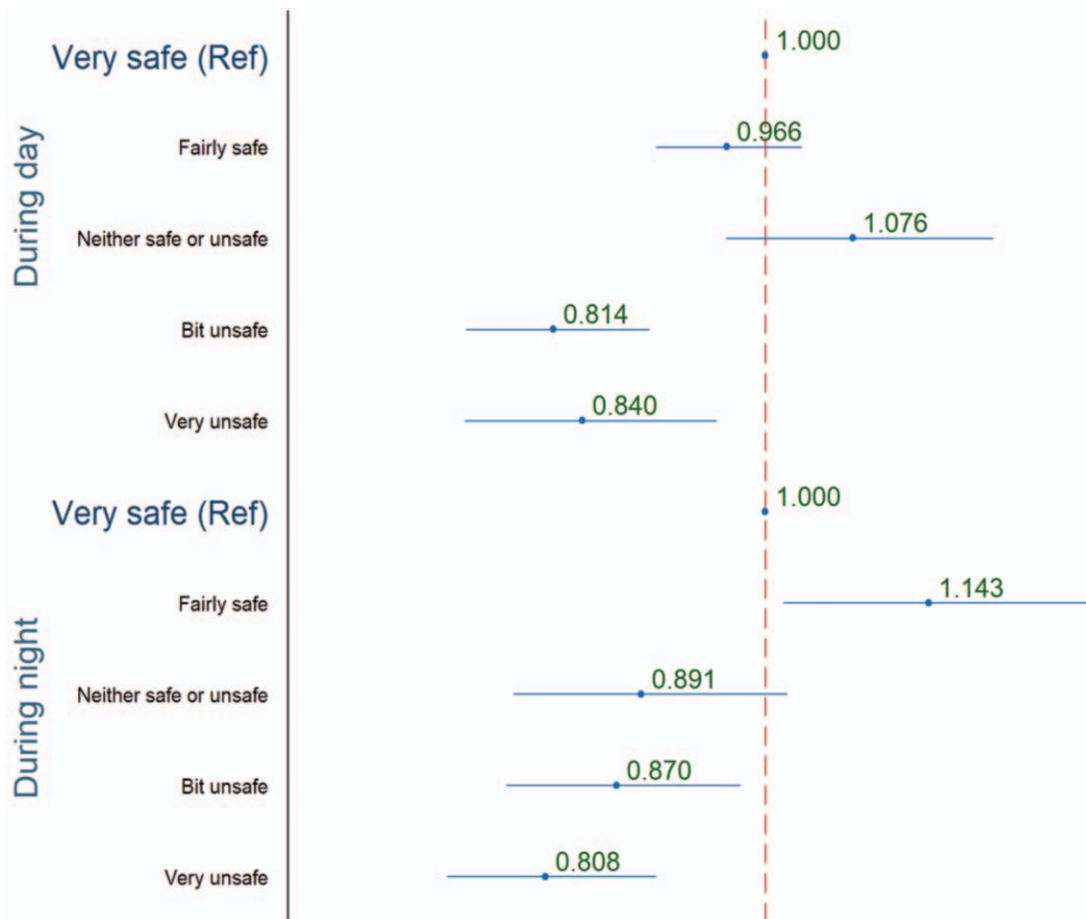
**3. Results**

**3.1. Sample characteristics**

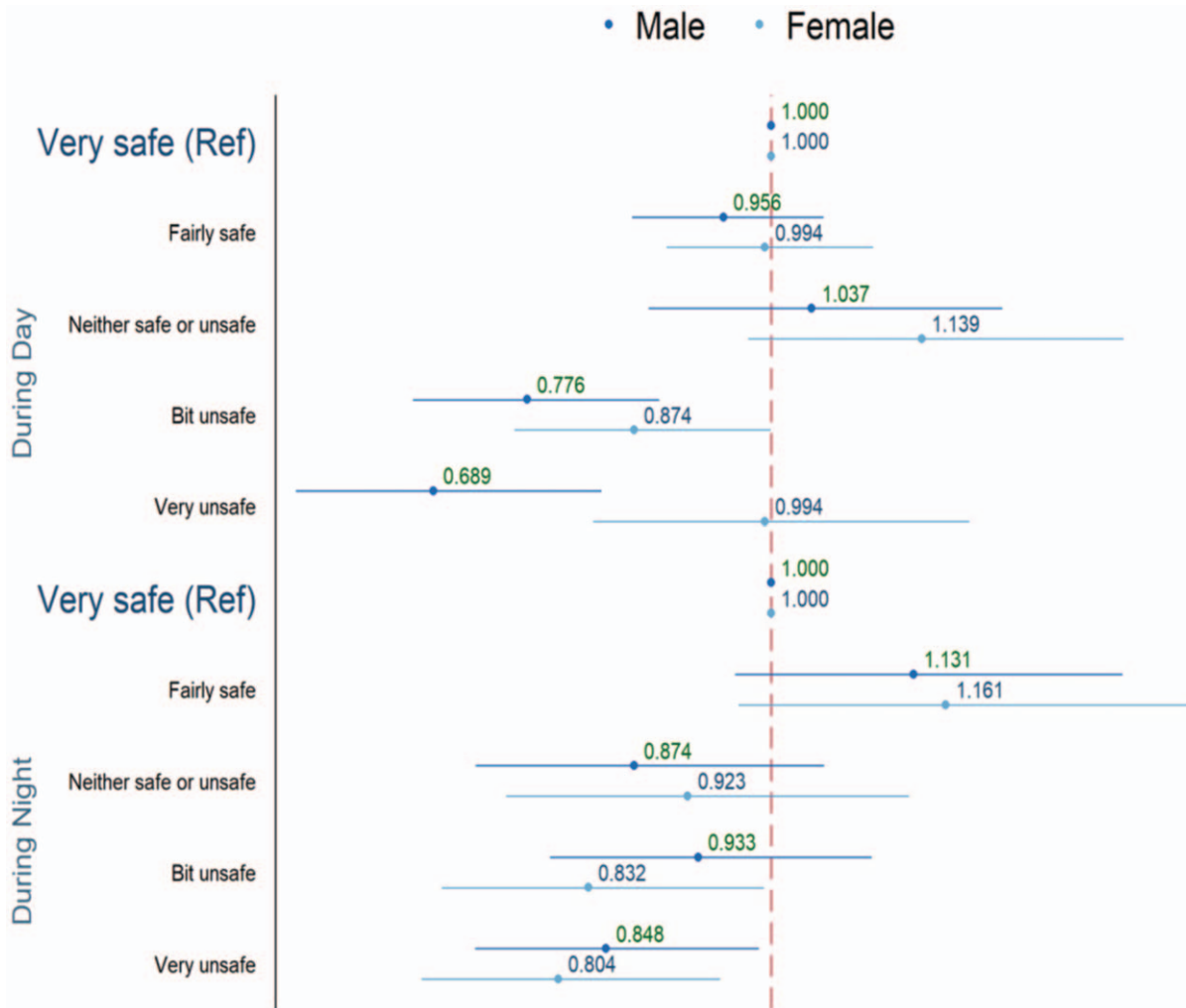
As shown in Table 1, less than a quarter (23.41%) of the participants reported taking exercise on daily basis while 27.90% reported never doing any exercise. The proportion of those who took exercise on daily basis was higher among the age group of 25 to 29 years, male (51.20%), of African background (76.5%), residents of Johannesburg (34.80%), had matric level education (35.10%), had employment (53.40%), had excellent health condition (45.2%), had no disability (94.90%). Table 1 also shows that 6.0% and 20.0% of the participants reported feeling very unsafe during day and night respectively, while 30.7% (during day) and 23.9% (during night) reported feeling very safe. (Figures 1 and 2)

**3.2. Multivariate analysis**

Figures 3–6.



**Figure 3.** Odds of association between perceived safety and physical exercise among Gauteng residents. Shows that respondents who reported feeling bit unsafe (OR=0.814,  $P < .001$ ) and very unsafe (OR = 0.840,  $P < .001$ ) by day had significantly lower odds of taking regular PE. Similar findings were observed for perceived lack of safety at night as well with the odds being: neither safe or unsafe (OR=0.891,  $P < .001$ ), bit unsafe (OR=0.870,  $P < .001$ ) and very unsafe (OR=0.808,  $P < .001$ ).



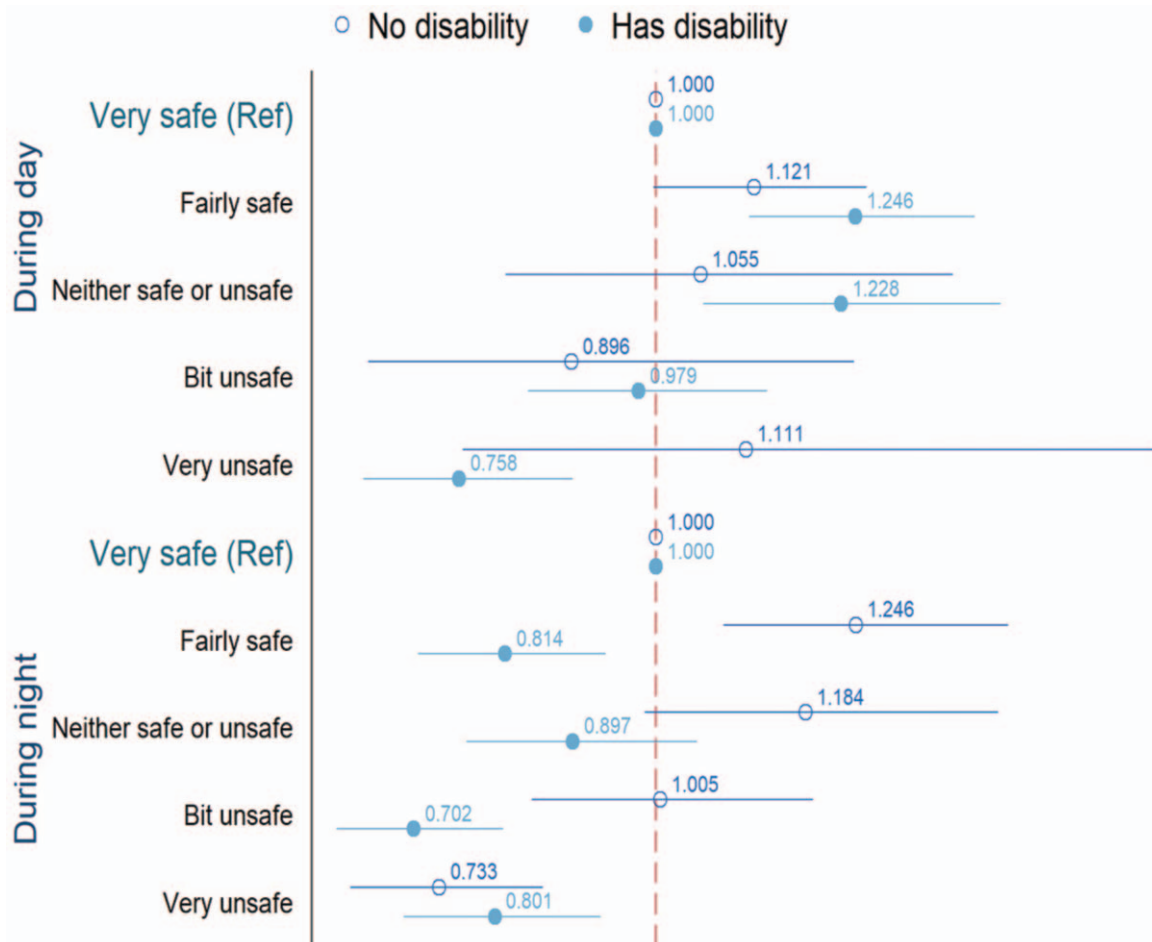
**Figure 4.** Odds of taking regular PA in association with perceived safety among men and women. Shows that results of the sex-stratified analysis were presented in Figure 4. PNS (bit unsafe) during day was associated with lower odds of PE both among men (OR=0.776,  $P < .001$ ) and women (OR=0.874,  $P < .001$ ). Reporting very unsafe during day was significantly associated with lower odds of regular PE among men only (OR=0.689,  $P < .001$  among men; OR=0.994,  $P = .276$  among women). Reporting very unsafe during night showed significant association with regular PE both among men (OR=0.848,  $P < .001$  among men and women (OR=0.804,  $P = .014$ ).

#### 4. Discussion

Based on the Quality of Life survey (2015/16), the present study reports the prevalence of perceived lack of neighborhood safety and its association with PE behavior in Gauteng, the smallest province in South Africa. Findings suggest that near about one-fifth of the participants reported lack of PNS (bit unsafe to very unsafe) during day. In contrast, more than three-fifth reported feeling unsafe during night, indicating that the safety concerns are far higher at night. After stratifying by age groups, we found that those aged between 25 and 29 had the highest percentage of reporting lack of safety both during day and night. Although the percentage dropped gradually with increasing age, it showed a sharp increase among the elderly groups (65+ years). This pattern was similar among both sexes. The age differential is hard to interpret as the situation is likely to vary across region and individual's socioeconomic standing. However, it is possible that the relatively higher percentage of safety concern among the elderly (compared with those aged 50–64) might stem from worsening health and frailty associated with aging. As expected,

the percentage of reporting lack of PNS was relatively lower among those who had no disability, but higher among those who reported hearing, communication and physical disability, with the exception for sight disability. People living with disability face exceptional difficulties in maintaining active lifestyle and experience increased vulnerabilities to criminal perpetration as well.<sup>[26,27]</sup>

In line with the first hypothesis, the findings indicated a significantly negative association between lack of perceived neighborhood safety and engaging in regular PE. The potential mechanism explaining this relationship may be that people's fear of experiencing crime and violence in the neighborhood can dominate their perceived health needs. This can induce the adoption of sedentary lifestyle or other recreational activities that involve little to no outdoor time spending especially among vulnerable population groups including women, children and the senior citizens. A longitudinal study on 19,000 US kindergartners from the Early Childhood Longitudinal Study found that children whose parents perceived their neighborhoods as unsafe spent

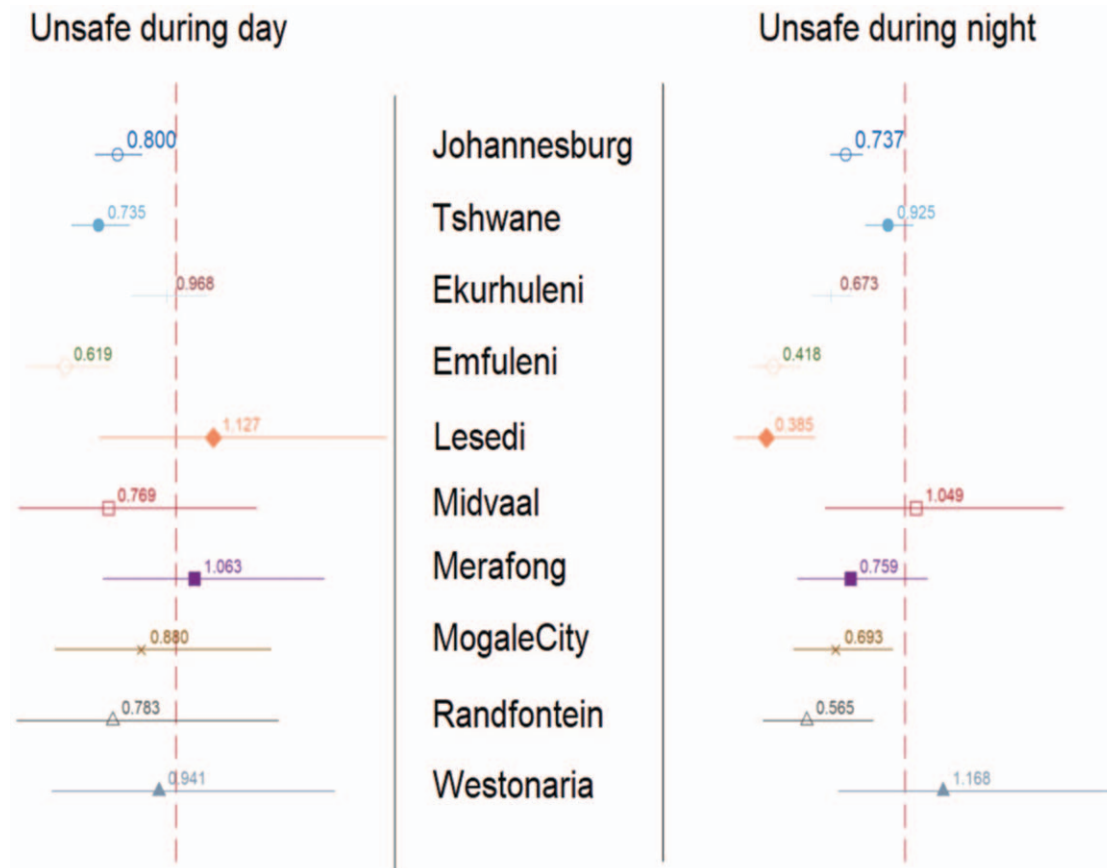


**Figure 5.** Odds of taking regular PA in association with perceived safety by disability status. Shows that following stratification by disability status, the results revealed that the negative association between PNS and regular PE was more pronounced among those living with disability (Fig. 5). For instance, those negative association between PNS and PE during day was significantly among those with disability only (OR=0.758,  $P < .001$ ). Similar patterns were observed for perceived lack of safety at night as well with the odds being: fairly safe (OR=0.814,  $P < .001$ ), neither safe or unsafe (OR=0.897,  $P < .001$ ), bit unsafe (OR=0.702,  $P < .001$ ). However, feeling very unsafe decreased the odds of regular PE among both who had (OR=0.733,  $P < .001$ ) and were free (OR=0.801,  $P < .001$ ) from any disability.

longer hours before television and had less engagement in physical activity.<sup>[28]</sup> This is particularly the case for children as their outdoor activities are guided by parents and the growing popularity of electronic and social media is allowing them to spend long indoor hours. In this context, one potential source of confounding can result from overreporting of crime and violence events and people’s exposure to such media reports. This means that people’s subjective assessment of crime situation in certain areas can prevent them from using outdoors activities even if the actual rate of crime is far lower than in other areas. With this context in mind, we performed a set of sub-group analyses for the 11 regions in Gauteng which showed an interesting contrast in the association between PNS and taking PE such that in certain regions the association was significant only during daytime (such as Tshwane) or night-time (such as Mogale city and Randfontein). The current data were not suitable to explain the regional differences, and therefore remains open for further explorations.

In line with the second hypothesis, we found that the inverse association between lack of PNS and PE was more pronounced among women and those living with disability. This hypothesis is chiefly based on the fact that individuals with lower socioeco-

nomics standing and those facing various discrimination can experience less security or increased feeling of susceptibility to crime and violence both at home and in the community. Moreover, men are often more affected and involved in crime and violence than women, and are more aware of criminal activities in their surroundings than females which allows them to take better preventive approaches. South Africa is regarded by many as the crime capital of the world and the socio-political landscape being characterized by high rates of poverty, socioeconomic inequality, and high crime rate<sup>[29]</sup>- three social evils.<sup>[30]</sup> Apart from these three key social challenges, a large body of research suggests that African women face serious socioeconomic marginalization and domestic violence that can hamper their empowerment potential<sup>[31]</sup> and diminish their confidence<sup>[32]</sup> and sense of dignity,<sup>[33]</sup> which in turn can prevent them from adopting healthy lifestyle behavior such as regular PE.<sup>[34,35]</sup> A USA based study (metropolitan Boston) including urban low-income housing complexes reported that residing in a neighborhood perceived to be unsafe at night was a barrier to regular PE especially among women, living in low-income housing.<sup>[36]</sup> In a similar manner, people living with disability also experience disproportionately



**Figure 6.** Odds of taking regular PA in association with perceived safety across the study regions. Shows that for sensitivity analysis, the associations were further analyzed by stratifying for place residency (Fig. 6). The results showed that perceived lack of safety during day was negatively associated with regular PE in Johannesburg (OR=0.800,  $P < .001$ ), Tshwane (OR=0.735,  $P < .001$ ) and Emfuleni (OR=0.619,  $P < .001$ ) only. In contrast, perceived lack of safety during night was negatively associated with regular PE in Johannesburg (OR=0.737,  $P < .001$ ), Ekurhuleni (OR=0.673,  $P < .001$ ), Emfuleni (OR=0.418,  $P < .001$ ), Lesedi (OR=0.385,  $P < .001$ ), Mogale City (OR=0.693,  $P < .001$ ), and Randfontein (OR=0.565,  $P < .001$ ).

higher incidences of violence and economic marginalization that curb their ability to maintain a healthy lifestyle. However, experience of crime and perception of safety are multidimensional issues and can relate to disability or sexual identity through complex pathways instead of having a straightforward relationship. Arguably, having physical or intellectual disability compromises one's independence of mobility and earning capacity which are more direct indicators of victimization than the state of disability itself.<sup>[37]</sup> Regardless of the etiology, addressing the sources of crime and violence should be treated as urgent social and health related goals as *living a life free from abuse and violence is a fundamental human right*.<sup>[38]</sup>

The present study has important research and policy implications. Given the rising burden of chronic diseases and changing health related behaviors such as sedentary lifestyle, understanding the factors that shape exercise behavior is an important public health imperative. The nature of exercise behavior is intrinsically environmental, and thus having an understanding of the associated factors can facilitate building an environment conducive for promoting a physically active lifestyle. While a vast majority of the existing studies are concerned with the demographic, sociocultural, and infrastructural indicators, the importance of environmental factors and social capital such as PNS received far less attention from

researchers, especially in the low-middle income countries. Several small scale studies have been published in the recent years such as one based on Prospective Urban Rural Epidemiology (PURE)<sup>[39]</sup> and on International Study of Childhood Obesity, Lifestyle and the Environment (ISCOLE). However, there is no study conducted on provincial level. From this perspective, our study makes an important contribution to the literature and provides the basis for more in-depth investigations in this particular area of public health and safety. Some notable strengths include the large sample size and region-specific analysis of the association between perceived safety and PE that provides a detailed and comparative scenario among the sub-regions of the province. An important aspect of this study is the region specific analysis of the association between perceived neighborhood insecurity and PE. We were also able to show the effects of the perceived neighborhood insecurity separately for day and night times, sometimes that is not usually done in similar surveys. Another mention worthy aspect of the survey was the inclusion of the separate questions on perceived safety for day and night period that allowed a more contextual analysis of the situation. Moreover, stratifying the analysis separately for men and women and disability status provides an additional insight on the demographic aspects of the perceived safety that may interest future researchers. Further studies are required to



advance the understanding of the mechanisms through which PNS influences exercise behavior and the way it interacts with the local demographic parameters.

Besides the contributions, there are several limitations to report as well. As the survey was cross-sectional, the direction of causality of the associations are hard to measure. Nonetheless, it is arguable that the reverse is not plausible since poor PE behavior cannot lead to low PNS. Longitudinal studies that control for the effect of physical or mental frailty on fear are needed to assess whether fear of crime contributes to the development of ill health. There was no data on the cause or source of the fear. It's important to distinguish perceived fear of crime from actual crime as there is often a mismatch between the two. Moreover, some individuals may suffer little or no crime and still fearful of real or hypothetical crime in future, whereas certain region might see an increase in crime rates over time without any change in the degree of fear among the public.<sup>[7]</sup> Some other potential limitations include lack of information regarding the health literacy of the participants which is a key determinant of PE, as well as quality of the neighborhood environment and presence of enough public space for taking PE. Thus, it is possible that the perception of unsafety and insecurity is more widespread among the inhabitants in certain communities than others even if the level of crime is similar or even less. The data being secondary, we were unable to control the measurement as well as selection of the variables. Last but not least, the self-reported nature of the data makes the findings subject to reporting bias.

## 5. Conclusions

Our findings indicated that about one-fifth of the participants in Gaoteng region reported lack of PNS (bit unsafe to very unsafe) during day. Reporting lack of safety both during day and night was associated with lower odds of engaging in regular physical activity. However, the findings may not be generalizable for the entire population as the sample population consisted of Gaoteng residents only. Although the survey was cross-sectional, the associations being stronger among women and people with disability deserve special research and policy attention. Future studies should focus on investigating the culture-specific sources of increased vulnerability among different socio-demographic population.

## Acknowledgments

We are thankful to the Gaoteng City-Region Observatory for the generous provision of the data. We highly appreciate the support of School of International Development and Global Studies, University of Ottawa and Southwest University of Political Science and Law.

## Author contributions

**Conceptualization:** Zhifei He, Yan Zhou.

**Data curation:** Zhifei He, Bishwajit Ghose.

**Funding acquisition:** Yan Zhou.

**Methodology:** Zhifei He, Bishwajit Ghose.

**Resources:** Sanni Yaya.

**Writing – original draft:** Zhifei He.

**Writing – review & editing:** Sanni Yaya, Zhaohui Cheng, Yan Zhou.

## References

- [1] Wet ND, Somefun O, Rambau N. Perceptions of community safety and social activity participation among youth in South Africa. *PLoS One* 2018;13:e0197549.
- [2] Sun VK, Stijacic Cenzer I, Kao H, et al. How safe is your neighborhood? perceived neighborhood safety and functional decline in older adults. *J Gen Intern Med* 2012;27:541–7.
- [3] Macassa G, et al. Fear of crime and its relationship to self-reported health and stress among men. *J Public Health Res* 2018;6:
- [4] Pearson AL, Breetzke GD. The association between the fear of crime, and mental and physical wellbeing in New Zealand. *Soc Indic Res* 2014;119:281–94.
- [5] Ross CE, Mirowsky J. Neighborhood disadvantage, disorder, and health. *J Health Soc Behav* 2001;42:258–76.
- [6] Saegert S, Winke G. Crime, social capital, and community participation. *Am J Community Psychol* 2004;34:219–33.
- [7] Curiel RP, Bishop SR. Fear of crime: the impact of different distributions of victimisation. *Palgrave Commun* 2018;4:46.
- [8] Choi H, Sloane D. Does working together prevent crime? Social capital, neighborhoods, and crime. *Oxf Handb Urban Econ Plan* 2011.
- [9] Takagi D, Ikeda K, Kawachi I. Neighborhood social capital and crime victimization: comparison of spatial regression analysis and hierarchical regression analysis. *Soc Sci Med* 1982;75:1895–902. 2012.
- [10] Yamaguchi A. Effects of social capital on general health status. *Glob J Health Sci* 2014;6:45–54.
- [11] Eriksson M. Social capital and health - implications for health promotion. *Glob Health Action* 4 2011.
- [12] Lindstrom M, Moghaddassi M, Merlo J. Social capital and leisure time physical activity: a population based multilevel analysis in Malmö, Sweden. *J Epidemiol Community Health* 2003;57:23–8.
- [13] Ueshima K, et al. Does social capital promote physical activity? A population-based study in Japan. *PLoS One* 2010;5:
- [14] Warburton DER, Nicol CW, Bredin SSD. Health benefits of physical activity: the evidence. *CMAJ Can Med Assoc J* 2006;174:801–9.
- [15] Vina J, Sanchis-Gomar F, Martinez-Bello V, et al. Exercise acts as a drug; the pharmacological benefits of exercise. *Br J Pharmacol* 2012;167:1–2.
- [16] Chomistek AK, Cook NR, Flint AJ, et al. Vigorous-intensity leisure-time physical activity and risk of major chronic disease in men. *Med Sci Sports Exerc* 2012;44:1898–905.
- [17] Dreisinger TE. Exercise in the management of chronic back pain. *Ochsner J* 2014;14:101–7.
- [18] Stafford M, Chandola T, Marmot M. Association between fear of crime and mental health and physical functioning. *Am J Public Health* 2007;97:2076–81.
- [19] Reiner M, Niermann C, Jekauc D, et al. Long-term health benefits of physical activity - a systematic review of longitudinal studies. *BMC Public Health* 2013;13:813.
- [20] Fredriksson SV, et al. How are different levels of knowledge about physical activity associated with physical activity behavior in Australian adults? *PLoS One* 2018;13:e0207003.
- [21] Writer, S. South Africa crime stats 2020: everything you need to know. <https://businesstech.co.za/news/government/421424/south-africa-crime-stats-2020-everything-you-need-to-know/>.
- [22] Jacobs, T. Social Media Use Is Linked to a Fear of Crime. *Pacific Standard* <https://psmag.com/news/social-media-use-is-linked-to-a-fear-of-crime>.
- [23] Heath L, Gilbert K. Mass media and fear of crime. *Am Behav Sci* 1996;39:379–86.
- [24] South Africa - Quality of Life Survey IV 2015-2016. <https://microdata.worldbank.org/index.php/catalog/3024>.
- [25] Hamer M, Muniz G, Demakakos P. Physical activity and trajectories in cognitive function: English Longitudinal Study of Ageing. *J Epidemiol Community Health* 2018;72:477–83.
- [26] Nixon M, Thomas SDM, Daffern M, et al. Estimating the risk of crime and victimisation in people with intellectual disability: a data-linkage study. *Soc Psychiatry Psychiatr Epidemiol* 2017;52:617–26.
- [27] Fogden BC, Thomas SD, Daffern M, et al. Crime and victimisation in people with intellectual disability: a case linkage study. *BMC Psychiatry* 2016;16:170.
- [28] Datar A, Nicosia N, Shier V. Parent perceptions of neighborhood safety and children's physical activity, sedentary behavior, and obesity: evidence from a national longitudinal study. *Am J Epidemiol* 2013;177:1065–73.

- [29] Perry EC, Potgieter C. Crime and Tourism in South Africa. *J Hum Ecol* 2013;43:101–11.
- [30] Cheteni P, Mah G, Yohane YK. Drug-related crime and poverty in South Africa. *Cogent Econ Finance* 2018;6:1534528.
- [31] Bishwajit G, Yaya S. Domestic violence: a hidden barrier to contraceptive use among women in Nigeria. *Open Access J Contracept* 2018;9: 21–8.
- [32] Kalra N, Tanna GLD, García-Moreno C. Training healthcare providers to respond to intimate partner violence against women. *Cochrane Database Syst Rev* 2017.
- [33] Karakurt G, Smith D, Whiting J. Impact of intimate partner violence on women's mental health. *J Fam Violence* 2014;29:693–702.
- [34] Rakovec-Felser Z. Domestic violence and abuse in intimate relationship from public health perspective. *Health Psychol Res* 2014;2: 21–8.
- [35] Friberg O, et al. Violence affects physical and mental health differently: the general population based Tromsø study. *PLoS One* 2015;10:e0136588.
- [36] Bennett GG, et al. Safe to walk? Neighborhood safety and physical activity among public housing residents. *PLoS Med* 2007;4:1599–606. discussion 1607.
- [37] Nixon, M. People with disability are more likely to be victims of crime - here's why. *The Conversation*<http://theconversation.com/people-with-disability-are-more-likely-to-be-victims-of-crime-heres-why-111999>.
- [38] Campos Pinto P. Out of the shadows: Violence against girls and women with disabilities in Portugal. *Alter* 2016;10:137–47.
- [39] Malambo P, Villiers AD, Lambert EV, et al. Associations of perceived neighborhood safety from traffic and crime with overweight/obesity among South African adults of low-socioeconomic status. *PLoS One* 2018;13:e0206408.