

SOCIAL CAPITAL, DEPRIVATION AND SELF-RATED HEALTH OF RESIDENTS OF GAUTENG: A MULTILEVEL ANALYSIS

James Wabwire Oguttu

A research report submitted to the Faculty of Health Sciences, University of the Witwatersrand, Johannesburg, in partial fulfilment of the requirements for the degree of Master of Science in Epidemiology: Epidemiology and Biostatistics.

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DECLARATION AND AGREEMENT BY CO-AUTHORS

DECLARATION

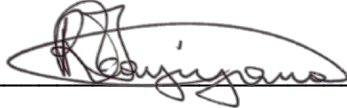
I, James Wabwire Oguttu, student number 1332945, declare that this research report is my own work and that I contributed adequately towards research findings.



Signature of student: _____ Date 19/10/2020

AGREEMENT BY CO-AUTHORS

James W. Oguttu, student number 1332945, wrote the protocol, acquired ethical approval, cleaned the data, performed data analysis, wrote the first draft and received critical comment from the co-author. By signing this declaration, the co-author listed below agrees to the use of the article by the student as part of his Research Report.



Jabulani R. Ncayiyana _____ Date 19/10/2020

DEDICATION

I dedicate this Master's degree to the following people who taught me the value of education and hard work: my late grandmother Mrs Faith Najjabi Muruya, my mother Ms Jane Rose Akoch and late father Mr. William Muruya Oguttu. I also dedicate this to my loving wife Prof Annet Oguttu for the unwavering support and for inspiring me to always desire to better myself. I also appreciate my children; Jonathan, Abigail and Timothy who had to put up with me not joining in family activities because I needed time to attend to this project.

PRESENTATIONS FROM THIS STUDY

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ABSTRACT

Social capital which is defined as resources and benefits derived through connections with others, has been linked to population health. However, few studies of the relationship between social capital and health have been conducted in developing countries. This study investigated the association between social capital and self-rated health (SRH) of the residents of Gauteng, and the impact Multiple Deprivation Poverty Index (SAMPI), a measure of area level deprivation, has on the relationship between social capital and SRH. We used retrospective data from the Quality of Life (QoL) survey conducted in 2015. A multilevel regression analysis of self-rated health (SRH) of a random sample of 27,476 individuals (after dropping none responses) aged 18 years and above, nested within 508 Wards was employed to achieve the objectives of the study. We fitted three models; Model 1 (the null model), Model 2 (regression of social capital variables and SRH) and model 3 (regression of social capital and SRH while controlling for socioeconomic and demographic variables). The median age of the respondents was 37 (Interquartile Range (IQR): 28) years. Slightly over half of the respondents (53.56%; $n = 14,717/27,476$) were females while the rest were males (46.44%; $n = 12,759/27,476$). No main effect of group membership (Adjusted OR (AOR): 1: 95% CI: 0.87-1.56) and registered to vote (AOR: 0.95; 95% CI: 0.82-1.10) was observed. However, if respondents were positive in their perception towards safety in community, there was a positive association with SRH (AOR:1.15; 95% CI: 1.01-1.31), but a strong negative association with SRH was observed if respondents had a negative perception towards safety in community (AOR: 0.70; 95%CI: 0.62 - 0.79). Variance between wards decreased from 23% (Model 2) to 13% (model 3). A strong positive joint effect on a multiplicative scale between satisfied with

safety in the community and the South African Multidimensional Poverty Index (SAMPI) was observed. While, a strong negative joint effect was observed on a multiplicative scale between dissatisfied with safety in the community and the SAMPI. Perception of the community towards safety in community is the core domain of social capital that impacts health of residents of Gauteng Province. While the impact of the interaction between the SAMPI and perception towards safety is independent of the level of the SAMPI, the direction of the interaction is dependent on whether the perception of safety is negative or positive. Variation in reporting good SRH in the study area, is explained by both individual and contextual factors. Findings of this study provide a basis for prioritizing policy formulation, programmes and interventions that increase the benefits of social capital and the resultant health benefit for a greater number of people in the study area. However, further studies are needed to further investigate the causal relationship between perception of safety in the community and SRH.

Key words: Social capital; self-rated health; multilevel regression, SAMPI; contextual factors, Gauteng City Region Observatory.

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CHAPTER ONE

1.1 Introduction

The potential impact of social capital on health is increasingly receiving attention in various fields like sociology, economics, political science, and public health. This is because of the evidence linking social capital to a number of health and wellbeing outcomes (Musalia et al. 2016; Tomita and Burns 2013). However, studies that have assessed the relationship between social capital and health, have concentrated on developed countries like Japan and the United Kingdom (1,4–7). For example, the protective effects of social capital on health inequalities has extensively been examined in *Anglo-Saxon* and *Scandinavian* countries with various welfare regimes (8,9). Meanwhile in low and middle-income countries (LMIC), the subject has received little attention. Furthermore, there have been fewer studies on social capital conducted in countries with underperforming health infrastructure, as is the case with many African countries. Yet given their robust associational life, these are countries that are likely to draw more benefit from harnessing the potential of social capital in improving the health of their populations (1).

In South Africa, studies that have looked at social capital have predominantly considered other health outcomes such HIV/AIDs, depression, tuberculosis etc., and not general subjective well-being (2,10,11). For example, only two studies by Lau, kwan & Ataguba (2015) and Chola and Alaba (2013) that assessed the relationship between social capital and self-rated health could be sourced. In addition, both studies by Lau, kwan & Ataguba (2015) and Chola and Alaba (2013) were conducted at national and not provincial level. Furthermore, majority of available studies have focused on social capital and general subjective well-being and other health outcome in other provinces of South Africa besides Gauteng province (10,13,14). Therefore, there is paucity of data on the relationship between social capital and self-rated health in South Africa in general and Gauteng specifically as a region (15).

It is just 25 years since the dismantling of the apartheid policies in South Africa, and the country is still undergoing extensive social reforms (14). Therefore, given the legacy of

racial and geographic segregation left by the apartheid era, South Africa provides a unique opportunity to examine the important role neighbourhoods and social capital play in health outcomes (2,14).

Therefore, there is a need for studies in a developing country like South Africa that assess the impact of social capital on health to provide contrast to establish whether social capital operates in a similar manner to influence health in communities that are so racially diverse and with high unemployment as is the case in Gauteng province (16). This study targets Gauteng Province, a highly skewed region in terms of the distribution of income and wealth, and ranks as one of the most unequal societies in the world (16). Therefore, the present study seeks to fill the existing knowledge gap through investigating the utility of the concept of social capital in understanding the health status of residents of Gauteng province. The study first considers the relationship between individual level social capital and health, and then adopts a multilevel analysis to delineate individual and contextual influences of social capital on Self Rated Health (SRH). Thirdly, the study investigates the role of the level of deprivation levels of neighbourhoods in the relationship between social capital and SRH.

1.2 Literature review

1.2.1 Social capital conceptualization

Available literature on social capital suggests some ambivalence with respect to its conceptualization and definition (Musalia 2016; Buijs et al. 2016; Subramanian, Kim, and Kawachi 2002). However, in public health, social capital is conceptualized as a resource like money, status, and information, or as features of social organization such as networks, norms and social trust that facilitate coordination and cooperation for mutual benefit (Hibino et al. 2012; Murayama, Fujiwara, and Kawachi 2012; Lau, kwan and Ataguba 2015; Tomita and Burns 2013; Buijs et al. 2016; Subramanian, Kim, and Kawachi 2002).

Social capital ranges from being an individual resource to being a community based resource embedded in social relations, to features of social organization such as networks, norms, and social trust that facilitate coordination and cooperation for mutual

benefit (Buijs et al. 2016; Subramanian, Kim, and Kawachi 2002). Therefore, social capital can be a collective/community and/or an individual variable (3,20).

Social capital conceptualized at community level includes the proportion of residents in the area who agreed that “most people would take advantage of you”, the density of membership in a civic organization and nation opinion poll data on interpersonal trust, and perceptions of reciprocity (Subramanian, Kim, and Kawachi 2002). Because social capital can be conceptualized as both a collective and an individual variable, it can thus be assessed using multilevel analysis (Hibino et al. 2012; Murayama, Fujiwara, and Kawachi 2012; Subramanian, Kim, and Kawachi 2002).

There are two schools of thought regarding social capital; the “social cohesion school” of social capital, which is always regarded as a group attribute, and the “network school” of social capital that can be conceptualized and measured as either a group-level or an individual-level construct. However, for purposes of this study, social capital is conceptualized as an individual variable, and will follow the conceptual framework that presupposes that social capital consists of two dimensions; the structural and cognitive social capital components (Lau, kwan and Ataguba 2015; Hibino et al. 2012; Murayama, Fujiwara, and Kawachi 2012; Musalia 2016; Subramanian, Kim, and Kawachi 2002).

Structural social capital refers to facets of social organization and networks such as associational activity and group membership like participation in voluntary or civic organizations that contribute to cooperation (Hibino et al. 2012; Kawachi et al. 1997; Subramanian, Kim, and Kawachi 2002). According to several authors the structural component of social capital actually refers to objectively measurable characteristics like participation in clubs, neighbourhood activities and other social networks (8,17). Rodgers et al. (3), go as far as saying that social capital refers to what people do for example voting.

On the other hand, the cognitive aspects of social capital manifests in the form of attitudes and perceptions such as trust and reciprocity among individuals (1,8). It could also be said that the cognitive aspect of social capital deals with mental processes that promote social cooperation such as trust, which can be personalized or generalized trust

(Subramanian, Kim, and Kawachi 2002). The second part of the cognitive aspect of social capital includes people's perceptions of the level of inter-personal trust, sharing, and norms of reciprocity (Lau, kwan and Ataguba 2015; Hibino et al. 2012; Murayama, Fujiwara, and Kawachi 2012; Subramanian, Kim, and Kawachi 2002), or simply put, what people feel (3).

1.2.2 Social capital and its impact on health

The role of social capital as an important determinant of major health outcomes has been demonstrated in many studies (3,8,20,21). There is overwhelming evidence that points to the fact that individuals with more social capital are more likely to have better health and live longer. For example, Subramanian et al. (2002), in their study titled "Social Trust and Self-Rated Health in US Communities: a multilevel Analysis", observed that higher levels of community social trust were associated with decreased probabilities of reporting poor health. Furthermore, there is evidence that suggests that individuals with strong networks tend to have mortality rates that are half or one third that of those with weak ties (1,20,21). It is in view of such findings, that the World Health Organization (WHO) decided to incorporate social capital into its general conceptual framework on social determinants of health (8). Furthermore, in the newly developed WHO policy for health for Europe, social capital has been identified as a protective and promoting factor of health (3). The question then, is how does social capital work to achieve good health and longevity for individuals?

According to Musalia and others (2016), social capital is a resource accessed by individuals by virtue of being members of a community. The same authors (1), are of the view that social capital as a resource, is constituted and disbursed through membership in social networks and features of social organization that include norms and social trust. Therefore, through individuals deploying networks as an asset, they can derive benefit for themselves or their communities. How social capital works to bring about improved health, is based on the fact that networks enable social cohesion by enabling cooperation between individuals irrespective of whether they know each other or not, facilitating spread of information and norms regarding health-related behaviors, promotion of access to and utilization of health services, provisions of economic and material resources, and

the fostering of psychological support (Rodgers et al., 2019; Subramanian et al., 2002). For example, a community of parents who know and trust each other is likely to be more effective at exercising informal social control over the deviant health behaviors of children in the community, like smoking and alcohol abuse (Subramanian 2002). Therefore, through cohesion and cooperation fostered by social networks, communities or individuals can realize better lives because they feel safe. The result of this, is improved health outcomes. Furthermore, it has been established that at aggregate level, social capital positively influences economic and political systems, and crime levels among other benefits (Musalia 2016; Subramanian, Kim, and Kawachi 2002).

Buijs et al. (8), are of the view that social initiatives that have potential to increase cohesion, co-operation and interpersonal trust can lead to a decrease in socioeconomic inequalities among persons with low and high SES. More details on how social capital influences health can be found in the work by Musalia et al. (2016), who discuss in details the hypothesized pathway through which social capital influences health. How social capital impacts on health outcomes like welfare of households has also been described in details by other authors (14).

The foregoing discussion notwithstanding, some authors have suggested that the relationship between social capital and health outcome can be complex and nuanced (10,14). For example, the effect of social capital can vary over time, as was demonstrated by Maluccio, Haddad and May (2000) in their study in Kwazulu Natal, province of South Africa. Van Hooijdonk et al.(2008) concluded from their study that the association between social capital and health can vary with health outcome, study population and the place where the study is conducted. Furthermore, social capital may have negative effects on health or health outcomes. For According to Rodgers et al.(2019), social capital has potential to adversely affect health in some scenarios. For example, through the spread of unhealthy norms and behaviors like smoking, social capital can adversely affect the health of a population. Details on how social capital works to negatively impact on health has also been described in details by Musalia et al. (2016). However, generally the hypothesized direction of association in most public health studies is clearly in the positive direction, in that greater social capital results in better physical health.

1.2.2 Deprivation and self-rated health (SRH)

There is evidence from several cross-national studies to suggest that the degree of income inequality in a given society is related to the society's and individual's level of health outcome (20–23). For example, studies independently conducted in the USA demonstrated an association between income inequality on one side and mortality, SRH and mental health on the other (21–23).

It has also been suggested that inequality as a third variable could explain some of the observed relationship between social capital and the health outcome of concern (8). A possible explanation for this, is that a high deprivation in a community could mean a lower social capital and hence a lower SRH. In this context, the degree to which a community is deprived directly impacts the relationship between social capital and SRH. The later scenario is the preferred one by policy makers because it allows them to employ the degree to which communities are deprived as health resource. However, while it is important for policy makers to understand how social capital impacts on the well-being of communities and thus health, there is limited research on the nature of social capital mechanism (8).

Noble et al. (2006), describe deprivation as people's unmet needs. Meaning that deprived if they lack types of diets, housing, clothing, educational opportunities etc., that are customary. One of the methods used by the department of statistics (Statistics South Africa) to measure poverty is the South African Multidimensional Poverty Index (SAMPI) (25). The SAMPI, based on the Alkire-Foster method, measures poverty and deprivation level of the country, but it also measures the degree to which individuals or neighbourhoods are deprived.

Between 2001 and 2016 the proportion of South Africans who were multidimensionally poor dropped from 17.9% to 7.0%. However, between 2011 and 2016 the drop in the number of South Africans who were multidimensionally poor stagnated. Moreover, areas that were disadvantaged under apartheid still have the highest multidimensional poverty levels (26)

Besides inequality, South Africa has challenges of extreme poverty that has its roots in structural imbalance created during the apartheid era. In fact, past censuses have estimated that almost a fifth (2.4 million) of Gauteng's population live below the food poverty line, and that this number has been increasing (16).

Self-rated health (SRH) is a score of personal health status or a measure of health, derived from a question in survey forms: "How do you rate your health?" The answer is rated on a Likert scale ranging from excellent to poor (27). It is a measure of subjective well-being (SWB) that looks at the life satisfaction, i.e., subjective evaluation of the overall quality of life (8).

Self-rated health has proved to be a reliable indicator of the health status of respondents (1,2). It has been shown that self-reporting has a high predictive validity for mortality and morbidity, independent of other medical, behavioral or psycho-social factors. It has also been shown in longitudinal studies that SRH predicts the onset of disabilities (28). For example, a nationwide study (n= 11,702) conducted in Japan proved that SRH was a reliable predictor of mortality and morbidity (18). As a result, subjective evaluation of the overall quality of life is a stable indicator of the link between subjective wellbeing (SWB) and outcomes of health (8). There is growing evidence from research that shows the existence of a significant association between high SWB and positive health outcomes such as positive adolescent development, decreased suicide rates and increased health and longevity (18).

Available evidence from several cross-national studies done in various part of the globe suggest that the degree of income inequality in a given society is related to the society's level of health outcome (21). For example, according to Kawachi et al. (1997), two studies independently conducted in the USA, demonstrated an association between income inequality and mortality. Therefore, in a country like South Africa with one of the highest Gini coefficients depicting a high level of inequality (29), a high association between social capital and health is expected. Available evidence suggests that health gains incurred by increasing social capital benefit more the disadvantaged in society (8). This is supported by the suggestion that the influence of social capital might be less salient in egalitarian societies (8).

Although, there are studies that have looked at social capital and health outcomes like HIV in South Africa (10,13), the relationship between social capital and SRH has not been extensively explored (7,11). Furthermore, there is no evidence of studies that have assessed specifically the role of deprivation in the relationship between SRH and social capital.

Since the dawn of the new dispensation, the South African Government has put a lot of effort in developing programs and policies aimed at reducing poverty, social inequality in the South African population (7,24,30,31). Examples of such programmes, include Welfare-to-Work Programme (dubbed W2P) that aims to move youth who are on welfare to permanent lucrative employment or offer further education opportunities. The other such programme, is the National Development Plan (NDP) that is structured around 14 priority areas aimed at improving the life of all South Africans.

Such policies and programmes have the potential to enhance social capital and well-being. Buijs et al. (2016) have proposed that different welfare regimes have potential to modify the impact of social capital. It is therefore pertinent to examine the association between social capital and health particularly in areas like Gauteng City Region (GCR) as a way of assessing the impact these programmes and policies have had on the social capital of the citizenry. This is because social capital is potentially an important resource for improving health.

In view of this, there is a need for epidemiological studies that assess the relationship between social capital and SRH in the study area, when deprivation at area level is accounted for in a multilevel analysis framework. This is important because both social capital and health play important roles in development (7,10,19). Moreover, the concept of social capital is not strange to the South African institution of ubuntu, a concept of humanness and an expression of community life and collective responsibility (14).

A multilevel methodologies have proven to be a good basis for developing detailed contextual description of people's health perception, behavior and outcomes, which can lead to provision of healthier, and fairer social policies (28,32). In this study, a multi-level framework was adopted to predict the association between SRH as the outcome and

social capital as the independent variable, while controlling for demography and socioeconomic variables including deprivation at the area level. The study examines the impact of social capital on SRH from both individual and structural levels given that factors that affect health are multifaceted in nature and operate at both individual (influenced by socioeconomic and demographical factors) and structural levels (context, social and environment). We therefore hypothesize that even after controlling for other sociodemographic determinants of health (e.g. gender, age, education, race, employment status, residential status), social capital and SRH among residents of Gauteng are significantly associated. We also further hypothesize that area level deprivation as measured by the SAMPI impacts on the relationship between social capital and SRH.

1.3 Problem statement

In South Africa the role of social capital research for health policy has not been given sufficient attention (7). Yet it is known that comparability of self-reported information can vary across social groups even within countries (4). Therefore, studies done elsewhere, be it at local or national level, cannot be used to deduce how social capital relates to health in other areas. As a result, since there is no evidence of studies that have assessed how SRH relates to social capital at individual, and community level, and how community level of deprivation influences this relationship, there is a gap in the knowledge of the relationship between social capital and health among residents of Gauteng. Furthermore, given the limited time schedule and that only data from Gauteng could be sourced, the present study will focus on Gauteng. In view of this, the proposed study will contribute to improved understanding of the role social capital plays on the wellbeing of residents in the province. This will in turn act as a stimulus for formulation of policies, programmes and interventions that increase social capital for a greater number of people in the study area.

1.4 Conceptual framework

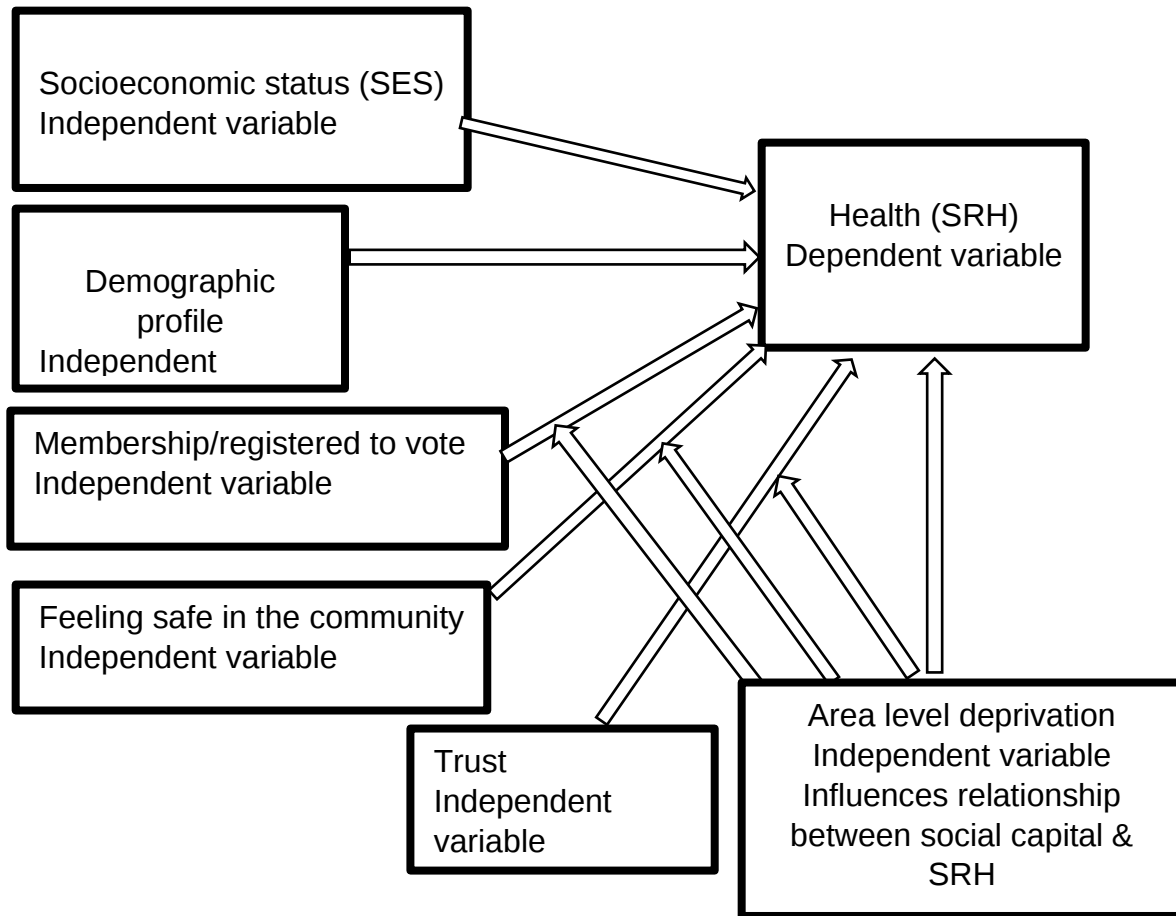


Figure 1:1 Conceptual framework of the relationship between SRH (independent variables). It also shows the possible interaction between social capital and deprivation.

It is important to distinguish the independent effects of contextual determinants (neighbourhood deprivation level) and individual determinants (social capital) on SRH. To address the research questions that the present study seeks to answer, a theoretical framework encompassing several interlinked neighbourhood and individual-level characteristics was developed and employed in the present research. The framework is presented in Figure 1.1.

1.5 Aim, Research Question and Objectives

1.5.1 Aim of the study

The aim of the study was first of all to investigate the association between social capital and SRH, and secondly to investigate the role of area level deprivation in the relationship between social capital and SRH among residents of Gauteng aged 18 and above using the 2015 wave of the QoL survey data.

1.5.2 Research question

The objectives of this study are based on the following research questions:

- Among the residents of Gauteng, are social capital measures strongly associated with SRH?
- What role does area level deprivation (SAMPI) play in the association between social capital measures and SRH in the study area?

1.5.3 Specific objectives

Specific objective 1:

To investigate the association between social capital and SRH while controlling for covariates such as demographic and socioeconomic factors.

Specific Objective 2:

To assess the role of the SAMPI on the relationship between social capital and SRH.

1.6 Components of the research report

This research report consists of the following chapters:

Chapter 1: Introduction and Literature review: Provides the background to the problem, problem statement, aims, research questions and objectives of the study.

Chapter 2: Published manuscript (Published in the Journal SSM-Public Health).

Chapter 3: Over all conclusion and recommendations.

NB: Chapter 2 includes a detailed description of the methodology employed in this study. As a result, there is no chapter entitled: "Extended methodology"

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CHAPTER 2

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Social capital and self-rated health of residents of Gauteng province: Does area-level deprivation influence the relationship?

James W. Oguttu, PhD^{a,c} ¹, Jabulani, R. Ncayiyana, PhD^b

a Department of Agriculture and Animal Health, College of Agriculture & Environmental Sciences, University of South Africa, Pretoria, South Africa

b Division of Epidemiology & Biostatistics, School of Public Health and Family Medicine, Faculty of Health Sciences, University of Cape Town, South Africa

c Division of Epidemiology and Biostatistics, School of Public Health, University of Witwatersrand, Johannesburg, South Africa

Abstract

Although social capital has been linked to population health, there is a dearth of studies on the phenomenon especially in sub-Saharan Africa. We investigated the individual and contextual effects of social capital indicators (group membership, registered to vote, perception towards safety in community and generalised trust) on the self-rated health (SRH) of the residents of Gauteng province. We used data from the 2015 Quality of Life (QoL) survey, which included a random representative sample of 27476 residents (level 1) in 508 administrative wards (level 2). We employed a multilevel logistic regression to examine the association of social capital and SRH (good vs poor). After adjusting for individual and area-level factors, no main effect of group membership (Adjusted OR: 0.93:

¹ Corresponding author: Department of Agriculture and Animal Health, College of Agriculture and Environmental Sciences, University of South Africa, Division of Epidemiology and Biostatistics, School of Public Health, University of Witwatersrand, Johannesburg, South Africa.

Email address: joguttu@unisa.ac.za

Postal address: Department of Agriculture and Animal Health, College of Agriculture and Environmental Sciences, University of South Africa, Florida Campus, Private bag X11, Block B, Room 335, South Africa, Code:1710

95% CI: 0.85–1.02), generalised trust (Adjusted OR: 1.01; 95% CI: 0.89–1.49) and registered to vote (Adjusted OR: 0.95; 95% CI: 0.82–1.10) was observed. However, if respondents were positive in their perception towards safety in community, there was a positive association with good SRH (Adjusted OR: 1.15; 95% CI: 1.01–1.31); while if residents reported a negative perception towards safety in community, a strong negative association with good SRH (Adjusted OR: 0.70; 95% CI: 0.62–0.79) was observed. Both ward variance and median odds ratio (MOR) indicate significant differences in good SRH by wards. A strong positive joint effect on the multiplicative scale was observed between satisfied with safety and the ward-level South African Multiple Deprivation Poverty Index (SAMPI), while a strong negative joint effect was also observed on a multiplicative scale between dissatisfied with safety and the SAMPI. Perception of safety in community is the core domain of social capital that significantly impacts the SRH of residents of Gauteng. Although the effect of perception towards safety in community on good SRH is influenced by ward deprivation, the effect is not dependent on the level of deprivation. Contextual factors as evidenced by the persistent MOR, in addition to individual factors, explain variation in reporting good SRH in the study area. Findings reported in this study provide a framework for policy makers, other agencies and communities on intervention strategies that should be prioritized for the impact of social capital on health to be more effective.

Keywords: Social capital, self-rated health, multilevel logistic regression, SAMPI, contextual factors, Gauteng City Region Observatory

Introduction

Available literature on social capital suggest some ambivalence with respect to its conceptualization and definition (1–4). This notwithstanding, the relationship between social capital and population health is increasingly receiving attention in public health. This is due to the growing evidence linking social capital and health outcomes (4–7). Social capital can be conceptualized at both group and individual level. In this study, we conceptualize social capital at the individual level based on the conceptual framework that presupposes that social capital consists of two dimensions: the structural and cognitive components (4,8,9).

The structural dimension of social capital refers to facets of social organization and networks like associational activity and group membership that contribute to cooperation such as participation in voluntary or civic organizations (2,8). Cognitive social capital manifests as attitudes and perceptions, including trust and reciprocity among individuals (1,4,6).

Although the benefits of social capital are well known, knowledge of its impact on health is still limited (6). It has been shown that people with more social capital tend to have better health and/or live longer (1). For example, Subramanian et al. (2) observe that higher levels of community social trust were associated with decreased probabilities of reporting poor health. However, studies on the relationship between social capital and health have concentrated on the industrialised country context (4,9–17). Not enough attention has been given to the concept in low-developed countries, especially in sub-Saharan Africa, with weak health infrastructure (16). A systematic review of the

association between social capital and mental health found that out of 21 studies, only two were in developing countries (16). Lau and Ataguba (9) and Olamijuwon, Clifford Odemigwe, and De Wet (18) have attributed this dearth of studies to lack of data. Yet, given their robust associational life, these countries could benefit more from the potential social capital offers to improve the health of their populations (4,16,18).

Self-rated health (SRH) as a measure of well-being is based on subjective evaluation of the overall quality of one's life (1). It has proved to be a reliable indicator of the health status of respondents (4,7). Furthermore, SRH has a high predictive validity for mortality and morbidity, and in longitudinal studies, it is able to predict the onset of disabilities (2).

People are deprived when they lack what is customary (i.e., diets, housing, clothing and environmental and educational conditions). Statistics South Africa has designed the South African Multidimensional Poverty Index (SAMPI) which can be used to measure the level of poverty and deprivation in the country including the degree to which individuals or neighbourhoods are deprived (19). Investigation of social capital and population health should routinely consider neighbourhood effects such as soci-economic status (SES), poverty or deprivation levels (2). Studies have shown that SES or deprivation levels affect both social capital and health. Poortinga, Dunstan, and Fone (20) have suggested that neighbourhood deprivation have impact on the health of individuals. In light of the legacy of racial and geographic segregation of the apartheid era (i.e. a period when different racial groups were made to live and develop separately, and were grossly unequal), South Africa presents a good example of the role of neighbourhoods in health outcomes (7,21). Moreover, the South African population is characterised by weak social cohesion rooted in racial and gender discrimination, an ever-widening income inequality gap,

extreme violence, xenophobic attacks on foreign nationals and criminal victimization (18). South Africa with a Gini coefficient of income inequality of 63.4, is one of the most unequal societies. According to Kawachi et al. (22), the degree of income inequality in a society is related to the society's level of health. Moreover, the South African society has been associated with declining trust in political institutions, poor interpersonal trust and declining public safety. All these impact social cohesion and thus social capital (18).

Past studies in South Africa that explored the impact of social capital on health mostly consider health outcomes such as HIV/AIDS, depression, tuberculosis and social cohesion – and not subjective well-being (7,23,24). Only three studies that assessed the relationship between social capital and SRH could be sourced (9,18,25). However, these studies did not consider the influence of area deprivation level on the relationship between social capital and SRH. Moreover, these studies looked at social capital and general subjective well-being in provinces other than Gauteng. Therefore, studies that provide a contrast of how social capital operates to influence health in most SES unequal communities such as in Gauteng province are needed (26).

Our study investigates the contribution of social capital to the well-being of residents of Gauteng province. We first consider the relationship between individual-level social capital and SRH, then adopt a multilevel regression analysis to investigate the role of the individual social capital indicators on SRH. The study also investigates how area-level deprivation impacts the relationship between social capital and SRH.

Conceptual framework

The theoretical justification of the relationships we investigate is presented in the conceptual framework in Fig. 1 (Supplementary Material Fig. 1).

Methods

Research design

The present study adopted a cross-sectional study design used by the Gauteng City Region Observatory (GCRO) and described in the GCRO Technical Report (27).

Study setting

Gauteng province is situated in the central north-eastern part of the country and is the smallest of the nine provinces of South Africa (26,28). According to the 2019 mid-year population estimates, Gauteng has a population of 15,176,115 people, which constitutes 25.82% of South Africa's entire population (29), living on 18,178 square kilometres (28).

Study population

The study population consisted of a representative sample of residents of Gauteng included in the 2015 QoL survey of the GCRO.

Data sources

Individual-level data

The present study used individual data collected during the 2015 QoL survey of adults aged 18 years and older, using an improved questionnaire used in previous surveys. The questionnaire was first piloted by the GCRO and the results of the pilot study were worked into the final questionnaire (27).

The QoL survey used stratified multistage random sampling using the 2011 wards (n = 508) as the stratification variable. The enumerator areas (EAs) were selected using probability proportional to size (PPS) and the power allocation rule. The minimum number of respondents selected per ward (determined by PPS) was 30 from non-metro wards and 60 from metro wards with no ceiling. Details of the sampling and how representativity at ward level was achieved are described in the GRCO Technical Report (27).

A structured questionnaire with a total of 228 questions (224 closed and four open-ended questions) was used to collect the data. A Computer Aided Personal Interviewing (CAPI) method, which is a face-to-face interviewing method that utilises a portable electronic device such as a tablet, was used during fieldwork to collect the data. This methodology involves an interviewer reading the survey questions and then capturing the responses on the electronic device (27). The GCRO closely monitors data collection in real-time, ensuring that the collected data are of the highest possible quality and integrity. In addition, the GRCO implements rigorous checking and quality control processes that help to ensure that the data is of a very high quality (30,31).

Ward-level data

In 2011, Gauteng province had 508 wards. Wards were chosen as the geographical units of analyses, and this is because it was the smallest area at which Statistics South Africa computes the SAMPI. The SAMPI was included in the analysis as a community level variable.

Data Management and Analysis

Data management

The data was processed using the software Stata IC V.14.2 (StataCorp, Texas, USA). The SAMPI drawn from the 2011 census data was merged with the QoL survey data to create community-level variable. The SAMPI was converted into a categorical variable by generating quartiles.

Definition of key variables

The primary health outcome was SRH, captured on a four-point Likert scale and assessed by the question “How would you describe your own health status in the past 4 weeks? (excellent = 1 and 4 = very poor)”. SRH was reclassified as described by Subramanian et al. (2001) into a dichotomous variable (0 = poor health and 1 = good health) by collapsing the original categories (poor or very poor) into poor SRH (coded 0), with the remaining original categories (excellent, good) into good SRH (coded 1).

The structured dimension of social capital was measured using civic participation, assessed by the respondent’s participation in activities of any club or society (e.g. sports club), and if they were registered to vote or not. Participants responded yes (= 1) or no (= 0).

The cognitive dimension of social capital was assessed by generalized trust and perception towards safety in the community. Generalised trust was measure by the question; “Generally speaking, do you think that most people in your community can be trusted or that you need to be careful when dealing with people in your community?”, requiring a response on a three-point scale (1 = Most people can be trusted, 2 = You

need to be very careful, and 3 = Don't know). "Don't know" was considered a no response and was thus excluded from the analysis. This dropped the study population from 30,002 to 27,476 individuals nested within 508 wards. Perception of safety was assessed by the question "How satisfied are you with safety and security services provided by government where you live?", requiring a response on a five-point scale (1 = very satisfied and 5 = very dissatisfied). This variable was recoded into three levels as follows: 0 = neutral (neither satisfied nor dissatisfied), 1 = satisfied and 2 = dissatisfied.

The individual-level explanatory variables extracted from the data included demographic and socioeconomic variables (i.e. age, gender, population grouping, place of birth, employment status, education level and being a grant recipient). The area level deprivation was assessed using the ward-level SAMPI.

Justification of the analytical approach and data analysis

Justification of the analytical approach

Since the data used in this study was of a hierarchal nature, with individuals/household (Level 1) nested within wards (Level 2), a multilevel approach was adopted for the analysis (Wendel-Vos et al. 2008). Furthermore, since the outcome (SRH) was reclassified into a dichotomous variable, a multilevel binary logistic regression model was fitted to the data to investigate the association between social capital variables and the outcome. Area level deprivation is known to influence the health of residents. We therefore assessed the impact of the interaction between SAMPI and social capital indicators on the outcome (SRH).

Data analysis

Descriptive statistics were computed to estimate the proportions and their 95% confidence interval of respondents reporting good SRH by social capital variables and covariates. A two-level multilevel model was fitted to investigate the association between social capital and SRH.

Three multilevel models were fitted, with Model 1 (null model) an empty model fitted to serve as a benchmark for other models (1). The first step in multilevel regression analysis (Fitting Model 1), consists of a decomposition of the variance of the dependent variable into the different levels. The variance of the individual SRH was decomposed into two components: the within-ward variance and the between-ward variance. These two variance components can be obtained with a multilevel regression Model 1.

The multilevel regression equation for Model 1 is equal to:

$$Y_{ij} = \beta_{0j} + \varepsilon_{ij}$$

$$\beta_{0j} = \gamma_{00} + U_{0j}$$

With Y_{ij} representing SRH in ward j , β_{0j} the intercept for the ward j , ε_{ij} the individual residual, γ_{00} the overall intercept and U_{0j} the ward departure from the overall intercept. This model predicts the individual SRH by the average SRH of his/her ward and the ward SRH is predicted by the grand mean. Since the regression model has no predictors, the ward intercepts (i.e. β_{0j}) will therefore be equal or close to the ward means. The variance of U_{0j} , usually denoted T_{00} , will be equal to between-ward variance. As each individual will be assigned his/her ward mean as predicted SRH, the variance of ε_{ij} (usually denoted S^2) will be equal to the within-ward variance.

Model 2 (unadjusted model) included SRH (outcome) and the four social capital variables as explanatory variables. Model 2 investigated the extent to which area-level differences were explained by the individual composition of the areas. With the introduction of the individual-level variable social capital in Model 2 as a fixed effect, the equation is as shown below:

$$Y_{ij} = \beta_{0j} + \beta_{1j} (\text{Social Capital})_{ij} + \varepsilon_{ij}$$

$$\beta_{0j} = \gamma_{00} + U_{0j}$$

$$\beta_{1j} = \gamma_{10}$$

This model has two random components – i.e. (i) the variance of ε_{ij} , denoted S^2 ; and (ii) the variance of U_{0j} , denoted $T00$ – and two fixed parameters, i.e. γ_{00} and γ_{10} .

The full model (Model 3) accounted for all covariates at individual and community levels (i.e. the demographic variables, socioeconomic variables and the SAMPI). This was as Maluccio et al. (2000) observed, to account for fixed effects. In Model 3, the respondents' demographic variables, denoted COV were added as random factors to the previous model (Model 2). The equation is written as follows:

$$Y_{ij} = \beta_{0j} + \beta_{1j} (\text{Social Capital})_{ij} + \beta_{2j} (\text{COV})_{ij}$$

$$\beta_{0j} = \gamma_{00} + U_{0j}$$

$$\beta_{1j} = \gamma_{10} + U_{1j}$$

$$\beta_{2j} = \gamma_{20} + U_{2j}$$

Interaction on the multiplicative scale for the unadjusted (Model 2) and fully adjusted (Model 3) models was assessed by including an interaction term between the social capital variables and the SAMPI. Interaction on the additive scale was assessed by computing the relative excess risk due to interaction (RERI), attributable proportion (AP) and synergy index (S) (34,35). The intra-class correlation coefficient, median odds ratios

(MORs) and estimates of variance were computed to explain the proportion of total variance due to neighbourhood influence.

All the models were adjusted by the post-stratification weight as estimated by the GCRO to ensure that the sample represents the target population as closely as possible and to account for the differences in the different populations. The Akaike information criteria (AIC) and Bayesian information criteria (BIC) were computed to assess model fit. Significance for all the statistical analyses was set at $P < 0.05$.

Results

Descriptive statistics

Table 1 presents SRH among respondents ($n=30,002$) hierarchically clustered into wards ($n=508$) by demographic and socioeconomic characteristics.

Education

The education level “More than matric” had the highest proportion (96.56%) reporting good SRH. This was followed by those who had attained matric (94.72%). Respondents who had no education had the lowest proportion reporting good SRH (75.36%) (Table 1).

Table 1: Demographic and socioeconomic characteristics by SRH ($n=3002$)

Variable	Level	Poor SRH		Good SRH	
		n	%	n	%
Education level	No education	121	24.64	370	75.36
	Primary education	690	20.93	2,607	79.07
	Incomplete secondary	897	10.00	8,076	90.00
	Matric	523	5.28	9,377	94.72
	More than matric	232	3.44	6,519	96.56
	Unspecified	49	8.31	541	91.69
Age category	18–35	663	4.72	13,394	95.28
	36–49	529	6.28	7,895	93.72
	50–64	756	13.85	4,704	86.15

	> = 65	564	27.37	1,497	72.64
Gender	Male	1,000	7.17	12,953	92.83
	Female	1,512	9.24	14,537	90.58
Race	African	2,148	8.89	22,017	91.11
	Coloured	90	7.87	1,054	92.13
	Indian/Asian	28	4.42	605	95.58
	White	241	6.12	3,697	93.88
	Other	5	4.10	117	95.90
Place of birth	Born in Gauteng	1,720	8.97	17,461	91.03
	Migrated from another province	680	7.99	7,829	92.01
	Migrated from another country	112	4.84	2,200	95.16
Employment status of respondent	Employed	649	4.45	13,922	95.55
	Unemployed	655	8.04	7,493	91.96
	Other	1,208	16.59	6,075	83.41
SAMPI quartile	1 st Quartile	962	8.57	10,263	91.43
	2 nd Quartile	612	8.17	6,877	91.83
	3 rd Quartile	315	8.34	3,463	91.66
	4 th Quartile	623	8.30	6,887	91.70
Anyone in household receives grant?	No	867	5.01	16,429	94.99
	Yes	1,645	12.95	11,061	87.05
Membership of any club in last 12 months?	No	1,293	7.66	15,581	92.34
	Yes	1,219	9.29	11,909	90.71
People in your neighbourhood can be trusted?	Most people can be trusted	355	8.21	3,971	91.79
	You need to be careful	1,950	8.42	21,200	91.58
	Don't know	207	8.19	2,319	91.81
How do you feel about safety and security?	Neutral	485	7.51	5,971	92.49
	Satisfied	771	6.50	11,087	93.50
	Dissatisfied	1,256	10.75	10,432	89.25
Are you a registered voter?	No	366	6.00	5,737	94.00
	Yes	2,146	8.98	21,753	91.02

Age

Although the different age strata had more respondents reporting good SRH, the proportion reporting good SRH decreased with increasing age. The youngest age category (18–35 years) had the largest proportion (95.28%) reporting good SRH, while age group ≥ 65 years had the lowest proportion reporting good SRH.

Gender and race

Slightly more males (92.83%) reported good SRH compared to females (91.11%). Across each race group, the majority reported good SRH. However, among Indians/Asians and those classified as “Other” 96% reported good SRH. Among whites and coloureds, 93.88% and 92.13% respectively reported good SRH. Africans had the lowest proportion (91.11%) reporting good SRH.

Place of birth

With respect to “Place of birth”, far more individuals reported good SRH (Table 1). Immigrants from outside South Africa to Gauteng recorded the highest proportion (95.16%) reporting good SRH, followed by immigrants from other provinces other than Gauteng province (92.01%). Respondents born in Gauteng recorded the lowest proportion (91.11%) reporting good SRH (Table 1).

Employment status

In each category of employment status, the majority reported good SRH (Table 1), with more employed respondents reporting good SRH (95.55%), followed by the unemployed (91.96%). The category “Other” had the lowest proportion (83.41%) reporting good SRH.

Grant recipient and SAMPI

The category with no member of the household receiving a grant had more people reporting good SRH (94.99%), compared to 87.05% with a member in the household receiving a grant (Table 1). Each category of the SAMPI had more respondents reporting good SRH (Table 1); however, on average, each SAMPI quartile had the same proportion (92%) reporting good SRH.

Group membership

Among those who responded to the question “Were you involved with any club in last 12 months?”, the majority reported good SRH irrespective of whether they had participated in a club in the last 12 months or not (Table 1). However, respondents who had not participated in a club in the last 12 months had a slightly higher number (92.34%) reporting good SRH, compared to those who had participated (90.71%) in club activities in the past 12 months.

Trust for community members

The majority of those who responded to the question on whether people in the community could be trusted reported good SRH. On average, 92% reported good SRH irrespective of whether they responded to the question in the negative (91.79%) or affirmative (91.58%) or were neutral (91.63%) (Table 1).

Perception of safety and security in the community

With respect to how they perceived safety and security in the community, the majority reported good SRH. However, more who were satisfied with safety and security (93.50%) reported good SRH compared to those who were dissatisfied with safety and security (89.25) (Table 1).

Registered to vote

The majority who responded to the question “Are you registered to vote?” reported good SRH. This was irrespective of their response (Table 1).

Multivariable associations between SRH and social capital while accounting for individual-level variables and area-level deprivation (SAMPI)

The results of the three multilevel models are presented in Table 2. Model 1 shows that 26% (95% CI: 20–34%) of the observed variance in SRH is at ward level. The grand mean (average likelihood) of reporting good SRH by respondents (n=27,476) within the wards (n= 508) is 12.04 % (95% CI:11.26–12.87%).

Out of the two measures of cognitive social capital, only perception of community on safety was associated with SRH (Model 2). Compared to the referent category (Neither satisfied nor dissatisfied with safety in the community), a strong positive main effect of satisfied with safety in community on SRH was observed (Unadjusted OR: 1.16; 95% CI: 1.02–1.32). Dissatisfied with the safety in community was strongly negatively associated with SRH (unadjusted OR: 0.70; 95% CI: 0.61–0.77).

Both measures of structural social capital had a very strong negative association with good SRH in Model 2 (Table 2), with respondents who had group membership having lower odds (unadjusted OR: 0.83; 95% CI: 0.76–0.91) of reporting good SRH compared to those who did not belong to a club. Likewise, respondents who were registered to vote had lower odds (unadjusted OR: 0.64; 95% CI: 0.56–0.72) of reporting good SRH in comparison to the referent group.

After accounting for social capital variables, the amount of variance in reporting SRH attributed to ward level reduced slightly to 22% (95% CI: 0.17–0.30) (Model 2). The ICC reduced from 0.08 (95% CI: 0.06–0.94) in the null model to 0.06 (95% CI: 0.05–0.08) in Model 2. The MOR also reduced from 1.63 in the null model to 1.57 in Model 2. This

implies that the variance in reporting good SRH attributed to ward level reduced when social capital variables were accounted for in the model.

The AIC and BIC for Model 2 were lower than for Model 1. Therefore, accounting for social capital variables in the model led to a better model fit for the data.

In the fully adjusted model (Model 3) we accounted for the SAMPI, demographic and socioeconomic variables. No main effect measure was observed for both membership and registered to vote. While no effect measure was observed for trust, a strong association with SRH was observed for community perception towards safety. If respondents were dissatisfied with security in the neighbourhood, they had lower odds of reporting good SRH (OR 0.71; 95% CI: 0.59–0.86). But if respondents were satisfied with safety in the community, they had higher odds (OR: 1.15; 95% CI: 1.01–1.31) of reporting good SRH.

The variance in SRH attributed to ward level in Model 3 decreased to almost half of the variance in SRH in the null model. Thus, slightly over half of the variance in SRH at ward level (14% 95% CI: 10–20) was explained by the SAMPI, demographic and socioeconomic variables.

The ICC also dropped in Model 3 to just over half (0.04; 95% CI: 0.03–0.05) of the ICC of the null model (0.07; 95% CI: 0.06–0.9). Likewise, the MOR for Model 3 reduced to 1.43 compared to 1.63 for the null model. Since the ICC measures variability within the ward, it means that by accounting for the SAMPI, demographic and socioeconomic variables, the variability within the wards reduced drastically.

The MOR (a measure of the evidence of clustering) reduced in value, suggesting that the extent to which an individual reporting good SRH depended on the area they live in reduced drastically when all covariables were accounted for in the full Model 3. But since the MOR remained large (MOR = 1.42), it means that reporting of good SRH among residents of Gauteng to a great extent is depended on the area of residence.

Model 3 yielded the smallest AIC (113871.01) and BIC (14101.2). Therefore, the full model was the best fit for the data.

Table 2: Measures of association between individual and area characteristics and the outcome, and measures of variations and clustering in the reporting of good SRH among residents of Gauteng city region, 2015, obtained from multilevel logistic models*

Variable SRH	Model 1 OR (95% CI)	Model 2 OR (95% CI)	Model 3 OR (95% CI)
Individual level:	12.04 (11.26-12.87)		
Cognitive social capital			
People can be trust (No)		1(reference)	1(reference)
Yes		0.98(0.87-1.11)	1.01(0.89-1.49)
Neither dissatisfied nor satisfied (0)		1(reference)	1(reference)
Satisfied with community safety (1)		1.16(1.02-1.32) **	1.15(1.01-1.31) **
Dissatisfied with community safety (2)		0.69(0.61-0.77) ***	0.70(0.62-0.79) ***
Structural social capital			
Registered to vote (No)		1(reference)	1(reference)
Yes		0.64(0.56-0.72) ***	0.95(0.82-1.10)
Membership (No)		1(reference)	1(reference)
Yes		0.83 (0.76-0.91) ***	0.93(0.85-1.02)
Variance and clustering components:			
Level 2 variance	0.26(0.20-0.34)	0.22(0.17-0.30)	0.14(0.10-0.20)
Level 2 intra-class correlation	0.07(0.06-0.09)	0.06(0.05-0.08)	0.04(0.03-0.06)
Level 2 MOR	1.63	1.57	1.43
Sensitivity analysis:			
AU ROC curve	0.69(0.68-0.70)	0.69(0.68-0.70)	0.78(0.77-0.79)
Model fit			
AIC	15671.3	15498.90	13871.01
BIC	15687.74	15556.45	14101.2

<i>P</i>	<0.01	<0.01
*Multilevel models were estimated with mixed effects regression models implemented in STATA (version 14). All regression results are using survey weights. The regression is across 508 neighbourhoods. AIC = Akaike information criterion BIC = Bayesian information criterion Reference category in bracket MOR = Median odds ratio AU ROC: Area under the curve **p ≤ 0.05, ***p ≤ .01		

Interaction between area-level deprivation and social capital

While a strong joint effect was observed between the 2nd quartile of the SAMPI and feeling neutral towards safety in community on reporting good SRH (Adjusted OR 1.31; 95% CI: 1.05–1.62), this was not the case on the additive scale as interaction failed to reach significance (RERI: OR = 0.19; 95% CI: -0.13–0.51). On the contrary, interaction between each of the 1st, 3rd and 4th quartiles of the SAMPI and feeling neutral towards safety in community failed to reach significance on both the multiplicative and additive scales (Table 3).

Table 3: Assessing interaction between neutral to safety in community and SAMPI on the additive scale

Summary measures		Unadjusted model ²		Fully adjusted model ³	
Interaction between perception of safety in community and SAMPI quartile		OR (95% CI)	P-value	OR (95% CI)	P-value
Neutral to safety in community and 1 st Quartile					
Neutral to safety in community	1 st Quartile				
No	No	1 (reference)		1(reference)	
No	Yes	1.16 (1.01-1.34)	0.036	1.19(1.02-1.37)	0.022
Yes	No	0.95 (0.86-1.04)	0.257	0.96(0.86-1.06)	0.382
Yes	Yes	1.10(0.93-1.30)	0.288	1.07(0.90-1.28)	0.422
	RERI	-0.01(-0.26-0.23)	0.924	-0.07(-0.32-0.19)	0.609
	AP	-0.01 (-0.24-21)	0.925	-0.06(-31-0.18)	0.618
	S	0.89(0.08-9.92)	0.924	0.53(0.04-7.55)	0.637
Neutral to safety in community and 2 nd Quartile					
Neutral to safety in community	2 nd Quartile				

² Unadjusted Model 2: Covariates adjusted for included social capital and SAMPI

³ Fully adjusted Model 3: Covariates adjusted for included social capital, demographic and socioeconomic variables and SAMPI

No	No	1(reference)			
No	Yes	1.15(1.02-1.31)	0.025	1.12(0.98-1.27)	0.104
Yes	No	1.05(0.94-1.17)	0.384	1.00(0.89-1.12)	0.989
Yes	Yes	1.24(1.01-1.52)	0.044	1.31(1.05-1.62)	0.015
	RERI	0.03(-0.27-0.33)	0.840	0.19(-0.13-0.51)	0.242
	AP	0.03(-0.21-0.26)	0.838	0.15(-0.08-0.37)	0.196
	S	1.15(0.30-4.45)	0.838	2.67(0.41-17.56)	0.306
Neutral to safety in community and 3rd Quartile					
Safety in community	3rd Quartile				
No	No	1(reference)			
No	Yes	1.14(1.02-1.28)	0.026	1.14(1.01-1.29)	0.033
Yes	No	0.98 (0.85-1.13)	0.797	0.99(0.86-1.15)	0.927
Yes	Yes	1.28(0.95-1.72)	0.102	1.31(0.96-1.78)	0.085
	RERI	0.16(-0.26-0.57)	0.461	0.17(-0.26-0.61)	0.436
	AP	0.12(-0.17-0.41)	0.415	0.13(-0.17-0.43)	0.385
	S	2.26(0.29-17.77)	0.437	2.30(0.32-16.60)	0.410
Neutral to safety in community and 4 th Quartile					
Safety in community	4th Quartile				
No	No	1(reference)			
No	Yes	1.19(1.05-1.35)	0.008	1.21(1.06-1.38)	0.004
Yes	No	1.03(0.92-1.15)	0.557	1.06(0.95-1.19)	0.294
Yes	Yes	1.12 (0.91-1.38)	0.290	1.08(0.87-1.34)	0.496
	RERI	-0.10(-0.39-0.18)	0.485	-0.20(-0.49-0.10)	0.187
	AP	-0.09(-0.36-0.18)	0.507	-0.18(-0.49-0.12)	0.232
	S	0.54(0.07-4.11)	0.550	0.28(0.01-5.48)	0.403

A strong positive joint effect (Adjusted OR = 1.38 (1.19–1.59) was observed between satisfied with safety and the 1st quartile of the SAMPI on the multiplicative scale (Table 4). However, this was not true for the same variables on the additive scale (Adjusted RR: -0.09 (95% CI: -0.35–0.17).

A similar trend was also observed, with a strong joint effect observed on the multiplicative scale between the 2nd, 3rd and 4th quartiles of the SAMPI and satisfied with safety in the community, but not on the additive for the same variables.

Table 4 Assessing interaction between satisfied with safety in community and SAMPI on additive and multiplicative scales

Summary measures		Unadjusted model ⁴		Fully adjusted model ⁵	
Interaction between satisfied with safety in community and SAMPI quartile		OR (95% CI)	P-value	OR (95% CI)	P-value
Satisfied with safety in community and 1 st Quartile					
Satisfied with safety in community	1 st Quartile				
No	No	1 (reference)		1(reference)	
No	Yes	1.57 (1.40-1.77)	0.000	1.50(1.32-1.69)	0.000
Yes	No	0.96 (0.86-1.07)	0.464	0.97(0.87-1.08)	0.567
Yes	Yes	1.46(1.27-1.68)	0.000	1.38(1.19-1.59)	0.000
	RERI	-0.07(-0.33-0.19)	0.575	-0.09(-0.35-0.17)	0.503
	AP	-0.05 (-0.23-0.13)	0.582	-0.06(-0.26-0.13)	0.514
	S	0.86(0.51-1.45)	0.571	0.81(0.44-1.50)	0.499
Satisfied with safety in community and 2 nd Quartile					
Satisfied with safety in community	2 nd Quartile				
No	No	1(reference)			
No	Yes	1.54(1.38-1.71)	0.000	1.44(1.29-1.62)	0.000
Yes	No	1.03(0.92-1.17)	0.559	1.01(0.89-1.14)	0.930
Yes	Yes	1.66(1.40-1.96)	0.000	1.55(1.30-1.84)	0.000
	RERI	0.08(-0.23-0.40)	0.606	0.10(-0.21-0.41)	0.527
	AP	0.05(-0.13-0.23)	0.595	0.06(-0.13-0.26)	0.511
	S	1.14(0.69-1.90)	0.603	1.22(0.66-2.26)	0.525
Satisfied with safety in community and 3 rd Quartile					
Satisfied with safety in community	3 rd Quartile				
No	No	1(reference)			
No	Yes	1.53(1.38-1.28)	0.000	1.46(1.32-1.62)	0.000
Yes	No	0.97 (1.83-1.13)	0.707	1.02(0.87-1.20)	0.792
Yes	Yes	1.71(1.35-1.72)	0.000	1.54(1.21-1.97)	0.005
	RERI	0.21(0.23-0.57)	0.348	0.06(-0.36-0.48)	0.782
	AP	0.12(-0.11-0.41)	0.300	0.04(-0.23-0.30)	0.776
	S	1.42(0.72-17.77)	0.316	1.12 (0.51-2.49)	0.777
Satisfied with safety in community and 4 th Quartile					
Satisfied with safety in community	4 th Quartile				
No	No	1(reference)			
No	Yes	1.58 (1.42-1.76)	0.000	1.47(1.32-1.65)	0.000

⁴ Unadjusted Model 2: Covariates adjusted for included social capital and SAMPI⁵ Fully adjusted Model 3: Covariates adjusted for included social capital variables, demographic variables, socioeconomic variables and SAMPI

yes	No	1.03(0.92-1.17)	0.594	1.02(0.90-1.16)	0.727
yes	Yes	1.52 (1.29-1.78)	0.000	1.48(1.25-1.75)	0.000
	RERI	-0.10(-0.39-0.20)	0.516	-0.02(-0.31-0.28)	0.917
	AP	-0.06(-0.27-0.14)	0.530	-0.01(-0.21-0.19)	0.918
	S	0.84(0.49-1.43)	0.522	0.97(0.53-1.78)	0.917

The effect measures for interaction between dissatisfied with safety in community and the SAMPI on the multiplicative and additive scales are presented in Table 5. Apart from the 2nd quartile for which a strong positive joint effect was observed, a strong negative joint effect was observed on the multiplicative scale between the rest of quartiles of the SAMPI and dissatisfied with safety in community in the fully adjusted model. There was no interaction effect on the additive scale observed between dissatisfied with safety and all four levels of the SAMPI.

Table 5 Assessing interaction on additive and multiplicative scale between dissatisfied with safety in community and SAMPI

Summary measures		Unadjusted model ⁶		Fully adjusted model ⁷	
Interaction between dissatisfied with safety in community and SAMPI		OR (95% CI)	P-value	OR (95% CI)	P-value
Dissatisfied with safety in community and 1 st Quartile					
Dissatisfied with safety in community	1 st Quartile				
No	No	1 (reference)		1(reference)	
No	Yes	0.60 (0.53-0.67)	0.000	0.62(0.55-0.69)	0.000
Yes	No	0.93 (0.82-1.05)	0.260	0.91(0.80-1.40)	0.173
Yes	Yes	0.58(0.51-0.65)	0.000	0.62(0.54-0.70)	0.000
	RERI	0.05(-0.09-0.18)	0.500	0.08(-0.06-0.23)	0.264
	AP	0.08 (-0.16-0.32)	0.500	0.13(-0.10-0.37)	0.264
	S				
Dissatisfied with safety in community and 2 nd Quartile					
Dissatisfied with safety in community	2 nd Quartile				
No	No	1(reference)			
No	Yes	0.61(0.56-68)	0.000	0.67(0.60-0.74)	0.000

⁶ Unadjusted Model 2: Covariates adjusted for included social capital and SAMPI

⁷ Fully adjusted Model 3: Covariates adjusted for included social capital variables, demographic variables, socioeconomic variables and SAMPI

Yes	No	1.07(0.93-1.24)	0.319	1.11(0.96-1.28)	0.178
Yes	Yes	1.62(0.54-0.72)	0.000	1.62(0.53-0.72)	0.000
	RERI	-0.06(-0.24-11)	0.466	-0.16(-0.34-0.03)	0.108
	AP	-0.10(-0.38-0.18)	0.471	-0.25(-0.56-0.06)	0.117
	S				
Dissatisfied with safety in community and 3rd Quartile					
Dissatisfied with safety in community	3rd Quartile				
No	No	1(reference)			
No	Yes	0.62(0.56-0.68)	0.000	0.65(0.59-0.71)	0.000
Yes	No	1.12 (0.92-1.35)	0.254	1.09(0.89-1.32)	0.417
Yes	Yes	0.58(0.48-1.69)	0.000	0.64(0.53-0.77)	0.000
	RERI	-0.16(-0.40-0.08)	0.184	-0.09(-0.33-0.15)	0.468
	AP	-0.28(-0.71-0.15)	0.200	-0.14(-0.53-0.25)	0.478
	S				
Dissatisfied with safety in community and 4 th Quartile					
Dissatisfied with safety in community	4th Quartile				
No	No	1(reference)			
No	Yes	0.59(0.53-0.65)	0.000	0.62(0.56 -0.69)	0.000
Yes	No	0.96(0.83-1.10)	0.537	0.97(0.84-1.12)	0.645
Yes	Yes	0.64(0.55-0.73)	0.000	0.68(0.58-0.78)	0.000
	RERI	0.09(-0.07 0.25)	0.265	0.09(-0.08-0.26)	0.296
	AP	0.14(-0.10-0.39)	0.258	0.13(-0.11-38)	0.288
	S				

Interaction between all four quartiles of the SAMPI and the social capital variable trust did not reach significance on both the multiplicative and additive scales (Table 6; Supplementary material B).

In Table 7 (Supplementary material C), apart from the joint interaction between the 3rd quartile and group membership that did not reach significance, the joint effect between each of the 1st, 2nd and 4th quartiles with group membership in the unadjusted model was significant. However, this effect was attenuated and ceased to exist when the socioeconomic variables were accounted for in Model 3. Therefore, no interaction on both

the multiplicative and additive scale between group membership and all four SAMPI quartiles in Model 3 was observed.

Table 8 (Supplementary material D) shows a strong joint effect between each of the four quartiles of the SAMPI with registered to vote in the unadjusted model. But as was the case with group membership (Table 7; Supplementary material C), this effect was attenuated and disappeared when demographic and socioeconomic variables were accounted for in Model 3. Therefore, no interaction effect between “Registered to vote” and the four levels of the SAMPI on both the multiplicative and additive scales was observed in the final model.

Discussion

Researching social capital and well-being can potentially identify opportunities for policy makers to improve the health of individuals and communities (1). This study presents important findings on the association between social capital and SRH of residents of Gauteng. It evaluates the effect of interaction between the SAMPI and social capital on reporting good SRH for Gauteng residents from a population-based survey. Overall, the proportion of respondents reporting good SRH was higher for each category of the demographic and socioeconomic variables. This was true for all the categories of the SAMPI and social capital variables, suggesting that the majority of respondents generally exhibited good subjective health. In the full model (Model 3), only community perception of safety was strongly associated with reporting good SRH. If respondents were dissatisfied with security in their neighbourhood, they were less likely to report good SRH (OR 0.71; 95% CI: 0.62–0.79), compared to those who were neutral in their feeling towards the state of safety in their community. But if respondents were satisfied with

security in the community, they were more likely to report good SRH (OR 1.15; 95% CI: 1.01–0.31). It is worth noting that although the variance in SRH attributed to area reduced drastically when individual covariates were accounted for, it did not completely disappear. This means that area influences a respondent's chances of reporting good or bad SRH. This is supported by the fact that the MOR remained high in the final model, which suggests evidence of clustering of SRH at ward level. Finally, our findings confirmed the existence of significant joint effects between perception of safety in community and area deprivation level on reporting good SRH. However, no significant interaction between the SAMPI and all social capital variables on reporting good SRH was observed on the additive scale.

While a strong association was observed between perception of safety in community and SRH, this was not the case with other social capital variables (i.e. registered to vote, trust and group membership). Lack of association between trust and reporting good SRH in the present study is contrary to the findings of Subramanian et al. (2001) who observed that the extent of interpersonal (mis)trust between citizens was one of the social capital measures that constituted the core domain of social capital. Furthermore, the findings reported here contradict findings of a second study by Subramanian et al. (2002), in which they reported a strong correlation between the proportion of respondents who reported social mistrust and the proportion of residents in various US states who rated their own health as only “fair or poor”, as opposed to “excellent, very good or good”. Our findings also contrast with the observation by Sapag et al. (2008), who reported that neighbourhood social cohesion as measured by trust and reciprocity is associated with higher SRH. The fact that our findings differed with those of other researchers was

surprising. However, it has been noted that the impact of social capital on health outcomes varies with study setting, population studied and the health outcome studied (37). The authors are of the view that the declining trust in political institutions, poor interpersonal trust and declining public safety among South Africans (18) could explain why trust does not constitute the core domain of social capital in the study area.

A strong main effect for perception of safety on reporting good SRH was consistently observed for individuals in the study area. If a respondent was positive about safety, they were more likely to report good SRH, which was not the case if they were dissatisfied with safety in the area. This finding is consistent with findings of other researchers who concluded that how one feels about the quality of their neighbourhood is substantial for health (18). In Canada, subjective perceptions of neighbourhood security have also been associated with health outcomes (38). The fact that if a respondent was dissatisfied with safety in the area, they were less likely to report good SRH has also been reported by Warr et al. (2009), who observed that lower perceptions of neighbourhood safety were associated with poorer health. This is an important finding given that two-thirds of South Africans feel unsafe in their neighbourhoods (18).

A strong negative association was observed in the unadjusted model between group membership (OR: 0.83; 95% CI: 0.76–0.91) and registered to vote (OR: 0.64; 95% CI: 0.56–0.72). However, after adjusting for socioeconomic and demographic variables, no effect measure was observed in the final model for both variables. This contradicts the findings of Sapag et al. (2008), who observed that social participation was associated with lower odds (0.89, 95% CI: 0.89–1.06) of reporting good health. Lack of association between group membership and registered to vote, and SRH in the fully adjusted model,

suggests that once the full influence of socioeconomic, demographic variables and area-level deprivation are considered, group membership and registered to vote may have less influence on the health of the respondents in the study area. Given that Sapag et al. (2008) have observed that group membership as a measure of social capital can have a deleterious effect on reporting good SRH, the fact that when the full influence of socioeconomic, demographic variables and area-level deprivation were considered, group membership and registered to vote had no influence on reporting SRH among respondents in the study area is good news.

While the association between higher individual income and better health status is well established, the influence of relative wealth on individual/population health is only now beginning to receive prominence (Sundquist and Ahlen 2006). Over and above individual income, 'relative income' (society's income distribution) does impact the individual's health. This is confirmed by Kavanagh, Turrell and Subramanian (2006), who noted that area-level disadvantage was associated with poor SRH. Subramanian et al. (2001) also observed that the probability of reporting poor health decreased as state per-capita income increased. In view of this, we anticipated a negative interaction between the 4th quartile of the SAMPI (the most deprived areas) and social capital. This is consistent with the hypothesis that income inequality impacts health by eroding social capital (32). However, contrary to our expectations, the findings reported here failed to confirm the hypothesis that high deprivation levels erode the impact of social capital on health.

According to Subramanian et al. (2001), in terms of health while the place of residence matters for all income groups, it matters relatively more for low-income groups. On the contrary, our findings show that there was no strong effect measure due to interaction

between trust, registered to vote and group membership, and all four levels of the SAMPI, suggesting that the area level of deprivation does not influence the impact of these measures of social capital on the health of individuals.

Generally, a strong negative joint effect existed between the SAMPI and dissatisfied with safety, while a strong positive joint effect was observed between satisfied with safety and the SAMPI on reporting good SRH. These findings suggest that perception of safety in the community and area-level deprivation work jointly to heighten or dampen the impact of social capital on the chances of reporting good or poor SRH. More importantly, they suggest that a positive perception of safety in the community promotes the health of the community. In view of this, Auger et al. (2008) recommend that public health strategies to improve foetal growth should be aimed at neighbourhoods with low perceived security.

One way in which income distribution in communities affects the health of individuals is by diminishing social capital, which in turn manifests as erosion of social cohesion, increased social exclusion and conflict (32). Living in an area that falls in the most socioeconomically deprived is associated with lack of control, hopelessness and loss of respect attributed to inequality (32). We therefore had anticipated that high levels of deprivation would have a stronger interaction effect with social capital on both the multiplicative and additive scales. However, in this study, we only observed a joint effect on the additive scale across all four levels of the SAMPI and the perception towards safety in the community. Moreover, this interaction tended to be in the same direction (i.e. negative if perception towards safety was negative and vice versa) for all four levels of the SAMPI. Hence, our findings contradict those of Buijs et al. (2016) and Auger et al. (2008), who are of the view that by improving social capital (more specifically perception

of safety by the community), the most socioeconomically deprived would benefit most from the exercise.

After accounting for social capital variables, although the variation between wards remained high, it reduced to 23% (Model 2) from 27% (Model 1). Likewise, when socioeconomic and demographic variables were accounted for, the variance between wards decreased but this time it reduced drastically from 23% (Model 2) to 13% (Model 3). Since it did not completely disappear, it implies that variations in SRH in the study area is explained by both individual and contextual factors. This is consistent with findings of a US study in which the authors observed that both individual and contextual factors explained SRH (Subramanian et al. 2001). Findings of our study are also supported by Sundquist and Ahlen (2006), who concluded that neighbourhoods are important in the efforts to enhance the health of communities.

There is a view that the existence of unequal societies could have implications for individual health (18,32). For instance, Chaix et al. (2008) observe that neighbourhood environments influence blood pressure. In addition, the incidence of crime and extreme poverty do erode social capital (25). Therefore, Gauteng being one of the most unequal societies with a high crime rate, we postulated that the majority of people living in the province would report poor SRH. However, as shown in Table 1, this was not the case as most people in the study area reported good SRH by each socioeconomic and demographic variable. Could this be attributed to high social capital among the residents of Gauteng or is it that the respondents are using whatever stocks of social capital available to them for physical survival? Investigation of the stock of social capital among the respondents was outside the scope of the present study.

Limitations

Firstly, the study used secondary data and was thus limited to variables collected during the primary survey. Secondly, although the data was weighted to reflect the distribution of the census population in terms of demography and other biometric characteristics for the year of sampling, the results may not reflect the current situation in the study area due to high movement of people in Gauteng. Thirdly, it was not possible to determine a composite index for social capital because of the limited number of measures of social capital in the data set. Lastly, as is the case with observational studies that use questionnaires to collect data, non-response could have led to selection bias in this study.

Concluding Remarks

The aim of the preceding analysis was to improve understanding of the impact of social capital on individual health, and how deprivation at area-level impacts this relationship. Our findings elevate perception of safety in community as the core domain of social capital in the study area. We show that variation in health in society cannot be accounted for only by individual factors, as ward context is important. Given the strong joint interaction between perception of safety in the community as social capital variable and the SAMPI, the findings of the present study suggest the existence of a psycho-social pathway of relative income on the health of residents. However, our findings also show that this is not dependent on the level of area deprivation. From a policy perspective, managers interested in ascertaining the level at which interventions should be targeted, our findings support the idea of increasing the confidence in the level of safety in the area. This is likely to result in residents reaping the most benefits of the impact of social capital on the health of residents of Gauteng. To explain the high proportions of people reporting good

SRH, we recommend a study to investigate the level of the stock of social capital in the study area.

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Ethics approval

Ethics approval was obtained from the human Research Ethics Committee of the University of Witwatersrand (Ref M180144) before the study commenced. Permission to use secondary de-identified data (data without personal identification information for purposes of keeping respondents anonymous) was secured from the GCRO.

Declaration of competing interest

None.

CRedit authorship contribution

James W. Oguttu: Conceptualization, Methodology, Formal analysis, Writing - original draft, Project Administration. **Jabulani R. Ncayiyana:** Supervision, Methodology, Writing -review & editing.

Appendix A: supplementary data

Supplementary data to this article can be found online at

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CHAPTER 3

3.1 Over all conclusions and recommendations

The overarching objective of the present study was to investigate for the first time the association between social capital measures and self-rated health (SRH) among residents of Gauteng City Region Observatory (GCRO). The study also investigated the interaction between the area level deprivation as measured by the SAMPI and social capital, and how this interaction impacts on reporting good SRH among study participants.

Out of the four social capital variables (trust, group membership, registered to vote and perception of safety in the community), perception of safety in the community, emerged as the core domain of social capital in GRCO. A positive perception of the security in the area has a strong positive association with reporting good subjective wellbeing as measured by SRH. While on the other hand, a negative perception of security in the area has a deleterious effect on good SRH. In view of this, further studies are needed to shed more light on the causal relationship between the perception towards security in the area where one resides and his or her health.

Although it has been widely reported that a strong association specifically between the cognitive aspect of social capital variable, trust with SRH exists, this is not the case for the residents of Gauteng province. In view of this, finds reported in this study, demonstrate the complex and nuanced nature of social capital, in that social capital can have different effects on health outcomes in different areas and at different times. However, given the limited nature of our study in that it used cross-sectional data, we recommend follow up studies involving either panel data or longitudinal studies to establish or confirm our findings of no association between trust as a social capital measure and SRH. The importance of this finding is underscored by the fact that the impact of social capital on health can vary over time. We therefore recommend a follow up study in 3-5 years to assess the relationship between trust and SRH.

In view of the fact that the effect of both aspects of the structural components of social capital (registered to vote and membership of any group) on SRH diminished when the

individual factors were accounted for, means that the effects of the social capital variables on individual health are attenuated by individual characteristics (demographic and socioeconomic variables).

In light of the findings observed in this study, if a respondent resides in a ward that falls in least deprived (1st) and top two most deprived quartiles (3rd and 4th Quartiles) of the SAMPI, and have a negative perception towards security in the community (i.e., dissatisfied with safety), the result is a negative joint effect (i.e., lowered chance of reporting good SRH). Meanwhile if one is a resident in a Ward that falls in the 2nd Quartile of the SAMPI but still has a negative perception towards safety in the community, the result is a strong positive joint effect (i.e., heightened chances of reporting good SRH).

The strong joint effect observed between the two structural components of social capital (membership of a group and registered to vote) and the area level deprivation in the unadjusted model were attenuated by individual characteristics. Studies are needed to further understand the how individual characteristics attenuate the effect social capital on the health of the respondents.

The variance in SRH attributed to ward level is drastically reduced to about half of that observed when individual characteristics are accounted for, meaning that the variance observed in SRH at ward level is explained not only by individual factors but also variation between wards. Furthermore, the fact that a drop in the ICC to just over half of the ICC of the null model and that the MOR was low compared to that of the null model when individual characteristics (demographic and socioeconomic variables) were accounted for, we further concluded that individual factors lower the variability within the wards drastically. Based on these findings, we also concluded that the extent to which an individual reporting good SRH depended on the area they live in reduces drastically when all individual covariates were accounted for. But since the MOR remained large, it means

that reporting of good SRH among residents of Gauteng to a great extent is still depended on the area of residence.

Finally, our study shows that multilevel health research can rigorously analyse using multilevel modelling, whether contextual effects are truly derived from context or are derived from individual characteristics. The results also show that multilevel health promotion research, can demonstrate that community influences health above and beyond one's individual characteristics.

Since perception of the respondents in a community proved to be significant for reporting of SRH among the residents of Gauteng Province, the policy makers in the later need to adopt policies that will enhance the resident's perception towards security in the area. Likewise, communities that live in areas that fall under the 3rd and 4th Quartile, which also happen to be the most deprived need to work towards ensuring a positive perception towards safety in their respective areas of residents.

APPENDICES

4,1 Supplementary material

4.1.1 Supplementary material A: Figure 1

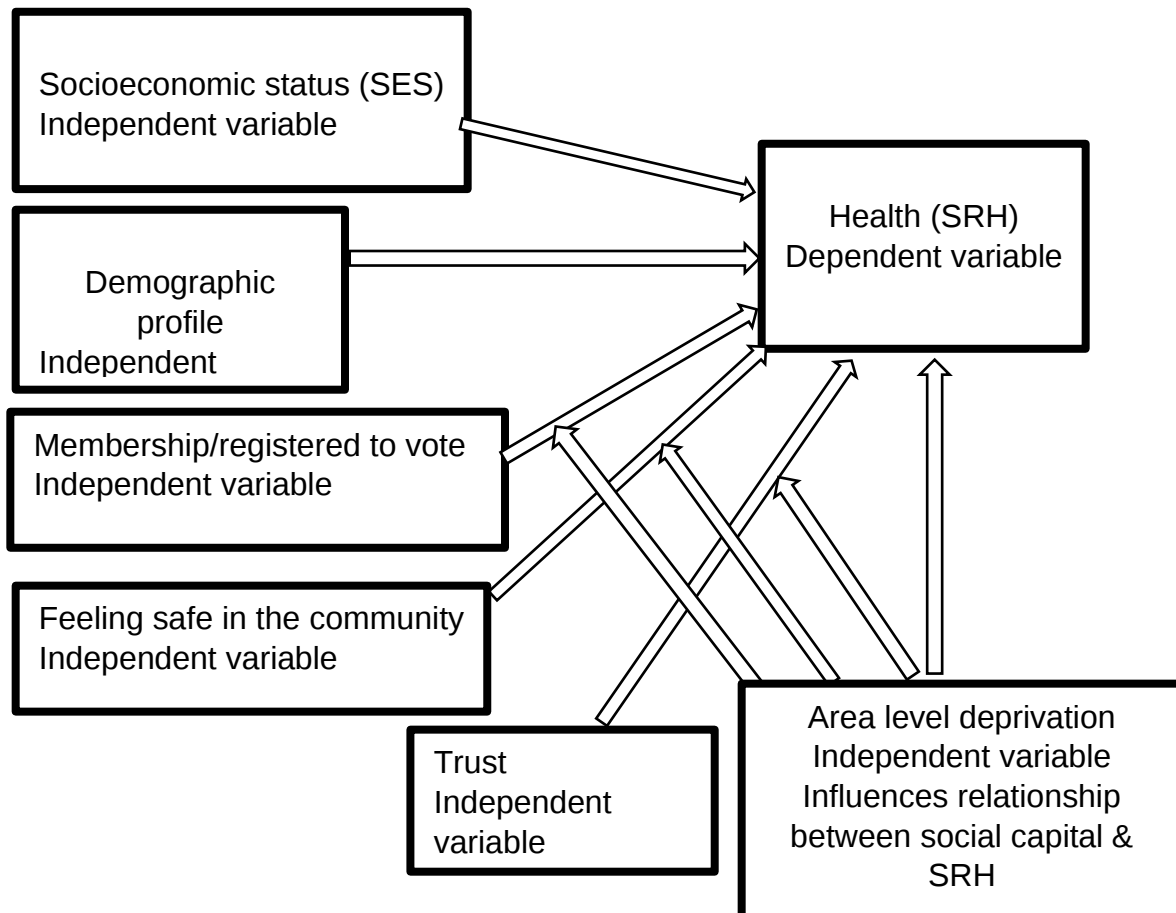


Figure 1. Conceptual framework to justify the relationship between SRH (independent variables). It also shows the possible interaction between social capital and deprivation.

4.1.2 Supplementary material B: Table 6

Table 6: Results of interaction on an additive and multiplicative scale for trust and the four levels of the SAMPI

SAMPI and Trust on the additive scale					
Summary measures		Unadjusted model		Fully adjusted model	
Trust & 1 st Quartile		OR (95% CI)	P-value	OR(95% CI)	P-Value
Trust	1st Quartile				
No	No	1 (reference)		1(reference)	
No	Yes	1.00(0.87-1.17)	0.933	0.96(0.82-1.13)	0.633
Yes	No	0.94(0.85-1.03)	0.203	0.94(0.85-1.04)	0.236
Yes	Yes	1.00(0.83-1.21)	0.976	0.98(0.81-1.19)	0.862
	RERI	0.06(-0.18-0.30)	0.647	0.08(-0.17-0.33)	0.526
	AP	0.06(-0.18-0.29)	0.638	0.08(-0.16-0.32)	0.511
	S				
Trust & 2nd Quartile					
Trust	2nd Quartile				
No	No	1(reference)		1(reference)	
No	Yes	1.07(0.94-1.23)	0.315	1.02(0.88-1.18)	0.743
Yes	No	1.08(0.97-1.20)	0.185	1.04(0.93-1.16))	0.534
yes	Yes	0.97(0.78-1.22)	0.821	0.93(0.73-1.18)	0.565
	RERI	-0.17(-0.45-0.10)	0.220	-0.13(-0.41-0.15)	0.370
	AP	-0.18(-0.49-0.14)	0.266	-0.14(-0.46-0.19)	0.405
	S				
Trust & 3rd Quartile					
Trust	3rd Quartile				
No	No	1(reference)		1(reference)	
No	Yes	1.04(0.92-1.18)	0.559	1.02(0.89-1.17)	0.758
yes	No	1.02(0.88-1.17)	0.820	1.07(0.93-1.24)	0.350
yes	Yes	0.98(0.73-1.32)	0.914	0.88(0.64-1.20)	0.418
	RERI	-0.07(-0.41-0.27)	0.685	-0.22(-0.55-0.12)	0.213
	AP	-0.07(-0.44-0.29)	0.699	-0.25(-0.69-0.20)	0.282
	S				
Trust & 4th Quartile					
Trust	4th Quartile				
No	No	1(reference)		1(reference)	
No	Yes	0.99(0.87-1.14)	0.941	0.96(0.83-1.10)	0.525
yes	No	1.00(0.89-1.11)	0.933	1.00(0.89-1.12)	0.983
yes	Yes	1.14(0.90-1.44)	0.271	1.12(0.88-1.44)	0.361
	RERI	0.15(-0.16-0.46)	0.335	0.17(-0.15-0.48)	0.295
	AP	0.13(-0.11-0.38)	0.290	0.15(-0.10-0.40)	0.245
	S				

4.1.3 Supplementary material c: Table 7

Table 7: Results of interaction between membership and the four levels of the SAMPI on the multiplicative and additive scales

Interaction between SAMPI and Membership on the additive scale					
Summary measures		Unadjusted model		Fully adjusted model	
Group membership	1st Quartile	OR(95%CI)	P-value	OR(95%CI)	P-value
No	No	1 (reference)		1 (reference)	
No	Yes	0.80(0.72-0.89)	0.000	0.90(0.80-1.01)	0.080
Yes	No	0.94(0.83-1.06)	0.331	0.91(0.79-1.03)	0.144
Yes	Yes	0.76(0.67-0.86)	0.000	0.90(0.79-1.03)	0.141
	RERI	0.02(-0.13- 0.17)	0.795	0.09(-0.07-0.26)	0.271
	AP	0.03(-0.17- 0.23)	0.794	0.10(-0.08-0.29)	0.266
	S				
Group membership	2nd Quartile				
No	No	1(reference)		1 (reference)	
No	Yes	0.82(0.75-0.91)	0.001	0.98(0.88-1.09)	0.690
Yes	No	1.12(0.97-1.30)	0.109	1.11(0.96-1.29)	0.158
yes	Yes	0.82(0.71-0.94)	0.004	0.91(0.79-1.05)	0.200
	RERI	-0.13(-0.33-0.07)	0.193	-0.18(-0.40-0.03)	0.097
	AP	-0.16(-0.41-0.09)	0.204	-0.20(-0.45- 0.05)	0.110
	S				
Group membership	3rd Quartile				
No	No	1(reference)		1 (reference)	
No	Yes	0.78(0.71-0.85)	0.000	0.91(0.82 -1.00)	0.050
yes	No	0.90(0.75-1.07)	0.224	0.92(0.77 -1.10)	0.362
yes	Yes	0.89(0.73-1.07)	0.217	1.08(0.88 -1.32)	0.460
	RERI	0.21(-0.02-0.44)	0.070	0.25 (-0.02 - 0.52)	0.060
	AP	0.24(-0.00-0.47)	0.046	0.23(-0.01- 0.46)	0.040
	S				
Group membership	4th Quartile				
No	No	1(reference)		1 (reference)	
No	Yes	0.81(0.73-0.90)	0.000	0.96(0.86-1.07)	0.442
yes	no	1.03(0.90-1.19)	0.657	1.07(0.93-1.23)	0.346
yes	Yes	0.81(0.71-0.93)	0.003	0.93(0.80-1.08)	0.369
	RERI	-0.03(-0.20-0.15)	0.719	-0.10(-0.31-0.11)	0.361
	AP	-0.04(-0.27-0.19)	0.721	-0.10(-0.33-0.13)	0.372
	S				

4.1.4 Supplementary material D: Table 8

Table 8: Results of interaction on the additive and multiplicative scale for registered to vote and the SAMPI

Summary measures		Unadjusted model		Fully adjusted model	
Assessing interaction between SAMPI and Registered to vote on the additive scale					
Registered to vote	1st Quartile	OR(95%CI)	P-value	OR(95%CI)	P-value
No	No	1 (reference)		1 (reference)	
No	Yes	0.64(0.55-0.75)	0.000	0.96(0.81-1.14)	0.679
Yes	No	1.03(0.82-1.31)	0.784	0.99(0.78-1.26)	0.945
Yes	Yes	0.60(0.51-0.70)	0.000	0.91(0.77-1.09)	0.315
	RERI	-0.07(-0.33-0.18)	0.564	-0.04(-0.30-0.2)2	0.747
	AP	-0.12(-0.53-0.29)	0.566	-0.05(-0.33-0.24)	0.745
	S				
Registered to vote	2nd Quartile				
No	No	1(reference)		1 (reference)	
No	Yes	0.64(0.56-0.74)	0.000	0.98(0.84-1.15)	0.816
Yes	No	1.23(0.93-1.61)	0.148	1.16(0.87-1.53)	0.308
Yes	Yes	0.66(0.56-0.77)	0.000	0.98(0.82-1.16)	0.791
	RERI	-0.21(-0.55-0.13)	0.231	-0.16(-0.51-0.1)8	0.354
	AP	-0.32(-0.83-0.19)	0.222	-0.17(-0.52-0.18)	0.348
	S				
Registered to vote	3rd Quartile				
No	No	1(reference)			
No	Yes	0.60(0.52-0.68)	0.00	0.92(0.80-1.07)	0.304
yes	No	0.83(0.60-1.15)	0.26	0.88(0.63-1.23)	0.470
yes	Yes	0.62(0.52-0.75)	0.00	0.99(0.81-1.20)	0.894
	RERI	0.20(-0.09-0.48)	0.17	0.18(-0.150.50)	0.284
	AP	0.31(-0.14-0.77)	0.18	0.18(-0.15-0.51)	0.281
	S				
Registered to vote	4th Quartile				
No	No	1(reference)			
No	Yes	0.59(0.51-0.68)	0.00	0.93(0.79-1.09)	0.358
yes	no	0.89(0.69-1.15)	0.38	0.95(0.73-1.24)	0.720
yes	Yes	0.62(0.52-0.72)	0.00	0.96(0.80-1.15)	0.668
	RERI	0.13(-0.10-0.37)	0.28	0.08(-0.19-0.35)	0.557
	AP	0.21(-0.18-0.60)	0.29	0.08(-0.20-0.37)	0.561
	S				

4.2 Data use agreement

DATA USE AGREEMENT BETWEEN
UNIVERSITY OF THE WITWATERSRAND, JOHANNESBURG,
UNIVERSITY OF JOHANNESBURG and GAUTENG
PROVINCIAL GOVERNMENT, acting through GAUTENG CITY-
REGION OBSERVATORY (GCRO)

(Hereinafter referred to as "The Licensor/Holder")

And

[JAMES W. OGUTTU]
The Licensee/Recipient

Interpretation and Definitions

1 In this Agreement, unless inconsistent with or otherwise indicated by the context:

1.1.1 "Data" means the whole or specific data taken from the 2015 Quality of Life 30 002 sample survey of residents of the Gauteng City-Region and includes, without prejudice to the generality of the foregoing, the know-how, formulae, processes, designs, sketches, photographs, plans, drawings, specifications, samples, reports, customer lists, pricing information, studies, findings, inventions, ideas, products (which may include GIS co-ordinates) or services of the Licensor, or other information connected with the products or services marketed, provided or obtained by the Licensor which is disclosed or made available to the Licensee directly or indirectly by licensor pursuant to this Agreement.

1.1.2 "GIS" means geographic Information System

1.1.3 "Licensor/Holder" is the University of the Witwatersrand, Johannesburg, the University of Johannesburg and the Gauteng Provincial Government acting through its Gauteng City-Region Observatory (GCRO);

1.1.4 the Licensor's address is 1 Jan Smuts Avenue Braamfontein, Johannesburg;

1.1.5 "Licensee/Recipient" is James Wabwire Oguttu

1.1.6 the Licensee's address is 27 Deneb Adige, Midstream Ridge, Ekurhuleni, 0140

1.1.7 "Parties" are the Licensor and the Licensee;

1.1.8 "Commencement Date" is the date of last signature of this Agreement;

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1.1.10.2 "Foreground Intellectual Property" means such any Intellectual Property developed by the Recipient its staff or students by using the specified data in terms of this agreement but excluding any Background Intellectual Property owned by the Holder.

1.1.11 words in the singular number include the plural and vice versa;

1.1.12 words importing any one gender include each of the other two genders;

1.1.13 a reference to a natural person includes a legal persona; and

1.1.14 save where reference is made to the first or last day of a month, "day" means Every day except Saturdays, Sundays and public holidays

1.2 The headings of the clauses are intended for convenience only and do not affect the interpretation of this Agreement.

This Agreement sets forth the terms and conditions pursuant to which the Licensor will disclose certain data, in its entirety or in the form of a limited dataset to the Licensee.

2. PERMITTED USES AND DISCLOSURES

Except as otherwise specified herein, the Licensor may make all uses and disclosures of the Data necessary to conduct the research described herein:

This study will investigate the relationship between Self-Rated Health (SRH) as the outcome and both social capital and deprivation (as individual and community level explanatory variables respectively) among residents of Gauteng. A cross-sectional study design adopted by the Gauteng City Region observatory will be adapted to answer the following questions. The overarching research question the study will answer is whether SRH is associated with social capital, and the role area level deprivation plays in this relationship among residents of Gauteng. Data collected during the 2015 wave on the residents of Gauteng province with a population estimated to be about 12- 13 million people (23.7% of the entire South Africa's population) will be used to achieve the objectives of this study.



In addition to the Recipient, the individuals, or classes or individuals, who are permitted to use or receive the Data for purposes of the Research Project include: 1. the student at the School of Public Health, *Dr James Wabwire Oguttu, who is also the principle researcher*; 2. the supervisor *Jabulani Ncayiyana*. To the extent that the classes of persons are not part of the Recipient's workforce who are directly involved in the Research Project, the Recipient shall enter into a data agreement with the other classes of persons before such release of the Data .

3. PERMITTED USE AND RESTRICTIONS

- 3.1. The Agreement allows the Recipient to use the data or data products for any lawful purpose on a non exclusive basis.
The Recipient will not use or disclose the data for any purpose other than permitted by this Agreement pertaining to the research project or as required by law;
- 3.2 The Recipient must never compromise the identity of individual respondents by analyzing responses using GIS co-ordinates at a level below ward, in order to ensure that no individual respondent can ever be identified.
- 3.3. The Recipient will use appropriate administrative, physical and technical safeguards to prevent use or disclosure of the data other than as provided for by this Agreement;
- 3.4. The Recipient will report to the Holder any use or disclosure of the data not provided for by this Agreement of which the Recipient becomes aware within 15 days of becoming aware of such use or disclosure;
- 3.5. The Recipient will ensure that any agent, including a subcontractor, to whom it provides the data, agrees to the same restrictions and conditions that apply through this Agreement to the Recipient with respect to the data;
- 3.6. The Recipient will not use the data for commercial gain and will advise the Holder of any envisaged commercial outcome immediately (upon discovering same), in writing.
- 3.7 In the event that commercially viable patentable work emanates from the research conducted in terms of this Agreement, the Parties will enter into an agreement, drafted by an attorney with particular expertise in patent law or specialist elected by the Licensor, on the standard terms and conditions as is usual for Agreements which regulate the commercialisation of any patentable work. Such commercialisation will however be subject to the Licensor's Deputy Vice-Chancellor (Research), deciding that commercialisation will not affect the academic requirements imposed on any student conducting research for the purposes of his/her course of study or will not affect publication in academic journals by the Licensor's staff, students, employees or assigns.
- 3.8 Nothing contained in this Agreement is to be construed as granting or conferring any right in, or title to the Intellectual Property, expressly or by implication to the Licensee.

4. TERM AND TERMINATION

The terms of this Agreement shall be effective as of 30/12/2017, and shall remain in effect until all information in the Data provided to the Recipient is destroyed or returned to the Holder.

It is required that once the agreed activities of the Recipient are ended, the Licensor is informed in writing, the data returned or destroyed, and notification in writing to this effect must be provided to the Licensor.

5. LICENSED RIGHTS

5.1 The Licensor hereby grants to the Licensee an exclusive, non-transferable, royalty free licence to use, photograph, copy and/or display images of the Data for the following purposes:

- 5.1.1 Teaching
- 5.1.2 Analysis and data mining
- 5.1.3 Writing research papers, journal articles, monographs, and other academic activities

5.2 In each instance the User must;

- 5.2.1 Include the following acknowledgement; *"The data used in this paper/report/book chapter or other work, is taken from the 2015 Quality of Life survey commissioned by the Gauteng City-Region Observatory, a partnership of the University of Johannesburg, the University of the Witwatersrand, Johannesburg, and the Gauteng Provincial Government"*
- 5.2.2 Share a copy of the Work with GCRO

5.3 The Licensee will be responsible for the payment of all costs and expenses incurred in the course of using, photographing, copying and/or displaying images of the Work/s for the purposes set out hereinabove.

5.4 By granting the License, the Licensor is not prohibited from granting the License to any other third party.

6 RIGHTS TO THE DATA

6.1 The Licensee acknowledges that all Intellectual Property rights, title and interest in and to the Data vests in the Licensor. The Licensee shall not at any time during or after termination or cancellation of this Agreement dispute the validity or enforceability of such rights or cause to be done any act or thing contesting or in any way impairing or tending to impair any part of that right, title and interest of the Data which may be the subject of this Agreement and shall not counsel or assist any other person to do so.

6.2 For the sake of clarity, the Licensee acknowledges and agrees that all Intellectual Property rights, title and interests in and to any intranet website, catalogue and publicity material containing images of the Data as set out in clause 6.1 hereinabove vests in the Licensor.

6.3 The Licensee will acknowledge the Licensor as the owner of the Data.



7. WARRANTIES BY THE LICENSOR

- 7.1** The Licensor warrants that it is free to grant the licence conferred by this Agreement.
- 7.2** The Licensor warrants that it is the owner of the Data.
- 7.3** The Licensor warrants that neither the Data nor the use, photographing, copying and/or displaying images of the Data will infringe the Intellectual Property rights of any third party.
- 7.4** The parties mutually agree that the Licensor retains all ownership rights to the data, and that the Licensee does not obtain any right, title, or interest in any of the data furnished by the Licensor. The Parties further agree that the Licensor makes no representation or warranty, either implied or express, with respect to the accuracy of any data in the dataset file(s).
- 7.5** The Licensee assumes the sole risk of interpreting and applying the Data and the Licensor is not in any way liable for any loss, damage or injury suffered by the Licensee or any other person, due to the use or possession of the Data or the existence of errors in the Data.

8. DISCLOSURE STATEMENT

- 8.1** This Agreement is subject to the Recipient providing the Holder with a detailed and complete disclosure, in writing and in line with the requirements of the Agreement, of the purpose for which the Data is to be used
- 8.2** Should the User intend using the Specified Data for the purposes of conducting research, then the disclosure in clause 8.1 should include the following;
- 8.2.1** the title of the research paper or project for which the Specified Data is to be used;
- 8.2.2** the details of the institution and supervisory body or person(s) under the auspices of which the research is to be undertaken;
- 8.2.3** an undertaking to supply Licensor with a copy of the final results of the research in printed and in electronic format; and
- 8.2.4** the assurance that no commercial gain will be received from the outcome from the research.
- 8.3** If the Specified Data is used in research with disclosure being provided in accordance with paragraph 8.1 and the Recipient is given the opportunity to receive financial benefit from the research following the publication of the results, then additional disclosure in terms of paragraph 8.2 is required.
- 8.4** The provisions of Clause 8 are subject to those contained in Clause 3 above.

9. General Provisions

- 9.1** The Recipient and Holder understand and agree that individuals who are the subject of the Data are not intended to be third party beneficiaries of this Agreement.
- 9.2** This Agreement shall not be assigned by the Recipient without the prior written consent of the Holder.

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9.3 Each party agrees that it will be responsible for its own acts and the results thereof to the extent authorized by law and shall not be responsible for the acts of the other Party or the results thereof.

By appending its signature hereto the Parties Agree to be bound by the terms and conditions contained herein.

Thus done and signed at: Florida, Johannesburg.. this 14th day of ...December.. 2017.

for The Licensor

As Witnesses

Name: Christyna Culwick 1 _____
Signature: [Signature] 2 _____
Capacity: Researcher

Thus done and signed at ..Florida, Johannesburg.. this...14th .day of December....2017.

For the Licensee

As Witnesses

Name: James W. Oguttu 1 [Signature]
Signature: [Signature] 2 [Signature]
Capacity: Principle Researcher/Post graduate Student _____

Schedule 1 (as per clause 8.1)

Title of the project: Social capital, deprivation and self-rated health of residents of Gauteng: a multilevel analysis

Institution and supervisory body:

The principle researcher is a registered student at the Wits School of Public Health, Division of Epidemiology and Biostatistics.

The study will be conducted under the supervision Jabulani Ncayiyana (PhD) from the Wits School of Public Health, Division of Epidemiology and Biostatistics.

Undertaking to supply Licensor (GCRO) with copy of final results

- The Principle Researcher undertakes to supply the Licensor with a copy of the final results of the research in printed and in electronic format.
- The Principle Researcher assures the Licensor that no commercial gain will be received from the outcome of the research.

Under taking to adhere to all restrictions

The PI undertakes to adhere to the restrictions set out in Clause 3 of the Data Use Agreement.


James Oguttu (Dr)



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4.3 Plagiarism form



Plagiarism declaration for written work: MSc/MPH

I ____James W. Oguttu_ (Student number: 1332945_) am a postgraduate student registered for the MSc/MPH in the Field of Population Based Field Epidemiology____ in the School of Public Health. I am submitting my written work for assessment for the module: Research Report Couse (Code: COMH7175).

I hereby declare the following:

- I am aware that plagiarism is the use of someone else's work without their permission and/or without acknowledging the original source).
- I am aware that plagiarism is wrong.
- I confirm that the work submitted for assessment for the above course is my own unaided work except where I have explicitly indicated otherwise.
- I have followed the required conventions in referencing the thoughts and ideas of others.
- I understand that the University of the Witwatersrand may take disciplinary action against me if there is a belief that this is not my own unaided work or that I have failed to acknowledge the source of the ideas or words in my writing.

Signature: _____

Date: 2019/07/15

4.4 Ethics clearance certificate



R14/49 Dr James W. Oguttu

HUMAN RESEARCH ETHICS COMMITTEE (MEDICAL)

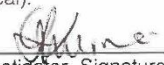
CLEARANCE CERTIFICATE NO. M180144

NAME: Dr James W. Oguttu
(Principal Investigator)
DEPARTMENT: Epidemiology and Biostatistics
School of Public Health
PROJECT TITLE: Social Capital, Deprivation and Self-rated Health of
Residents of Gauteng: A Multilevel Analysis
DATE CONSIDERED: 26/01/2018
DECISION: Approved unconditionally
CONDITIONS:
SUPERVISOR: Dr Jabulani Ncayiyana
APPROVED BY: 
Professor CB Penny, Chairperson, HREC (Medical)
DATE OF APPROVAL: 31/01/2018

This clearance certificate is valid for 5 years from date of approval. Extension may be applied for.

DECLARATION OF INVESTIGATORS

To be completed in duplicate and **ONE COPY** returned to the Research Office Secretary in Room 301, Third Floor, Faculty of Health Sciences, Phillip Tobias Building, 29 Princess of Wales Terrace, Parktown, 2193, University of the Witwatersrand. I/we fully understand the conditions under which I am/we are authorized to carry out the above-mentioned research and I/we undertake to ensure compliance with these conditions. Should any departure be contemplated, from the research protocol as approved, I/we undertake to resubmit the application to the Committee. **I agree to submit a yearly progress report.** The date for annual re-certification will be one year after the date of convened meeting where the study was initially reviewed. In this case, the study was initially reviewed in January and will therefore be due in the month of January each year. Unreported changes to the application may invalidate the clearance given by the HREC (Medical).


Principal Investigator Signature

Date

03/02/2018

PLEASE QUOTE THE PROTOCOL NUMBER IN ALL ENQUIRIES