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Activity and Time Spend Patterns of Residents in Low-Income Settlements in the City of Johannesburg, South Africa



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A research report submitted to the Faculty of Health Sciences, University of the Witwatersrand, Johannesburg in partial fulfillment of the requirements for the degree of Master of Science in Medicine (Exposure Science)

23 February 2023

Declaration

I **(Boipelo Hope Prudence Bhuda) with student no. 1841327** declare that this research project titled "*Activity and time spend patterns of residents in the low-income settlement in the City of Johannesburg, South Africa*" is my own, unaided work undertaken under the supervision of Dr Daniel Masilu Masekameni and Dr Daniel Mmereki. It is being submitted in partial fulfilment for the degree of Master of Science in Medicine (Exposure Science) at the School of Public Health, University of the Witwatersrand, Johannesburg. This work has not been previously submitted before for any degree or examination at any other University. The author designed the study, conducted data collection as well as data analysis and write-up of this research report. As per the plagiarism policy, a plagiarism declaration form is signed and attached as Appendix A.

Full Name of Student: Hope Prudence Boipelo Bhuda
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Signature:  Date: 23 February 2023

Dedication

I dedicate this report to my two handsome boys: Ntando and Nkosinathi Bhuda.

Abstract

Background

Human health risk assessment is concern about estimating the population exposure (HHRA) for environmental pollutants or contaminants. Exposure assessment for population-level require time-activity pattern distributions in association to microenvironments where individuals reside and spend their time**.** Time-activity patterns in South Africa have not been adequately explored, which may lead to wrong dose estimation for health risk assessment. No in-depth and systematic analyses of time-activity patterns in low-income communities have been done to date in South African context.

Aim

The aim of this study was to describe variations on time-activity patterns based on age, sex and socioeconomic status amongst residents of low-income communities in South African township (Matholesville informal settlement).

Methodology

A cross-sectional study design was adopted to assess time-activity patterns amongst low-income residents in South African townships. One Hundred and Thirty (130) households were selected randomly to participate in the study. A questionnaire survey comprising of key questions including demographics, type of household, type of activities conducting indoor, time spent on activities indoor and outdoor in a microenvironment, preferred season of the year and mode of transport commuting to different areas was administered to the study participants. In addition, diaries were used to get information on daily activity time pattern for seven (7) days. Completion of questionnaire were based on interviews with the study participants while diaries were self-administered by the participants daily over seven days.

Results

In this study, a total of 130 participants aged 18-35 and 36-75 years were included. Approximately 33% and 67% of the respondents were < 35 years and >35 years, respectively. This suggests that most of the households are headed by adults outside the youth age category. About 30 houses were found to be erected using bricks while 100 houses were made of corrugated iron.

About 75%, 14%, 8% and 2% of the study respondents were found to fall into the following race, black, coloured, Indian and white. Approximately (83% brick, 71% shacks) of the study

respondents attained secondary education the remainder of the respondents attained primary education. The most performed activities inside brick type dwellings are sleeping (100%), cooking (77%), cleaning (70%) and watching television (TV) (60%). While most performed activities indoors for shack dwellings are cleaning (87%), cooking (70%), sleeping (68%) and TV (37%). There is a high prevalence of none employed household heads at 53% for the brick dwelling and 63% for the shack dwellers. The average monthly income was found to be R4 304 and R3 650, for brick and shack type dwellings, respectively. Females were found to perform a larger proportion of indoor household activities than males. A total of 36% was spend on cooking and cleaning followed by 29% of the time watching TV in the brick type dwellings. For the brick dwellers spend 67% indoors and 33% outdoor while for the shack dwellers about 31% of the time is spend indoor.

Conclusion

The study had hypothesised that females above 18 years old residing in low-income communities are likely to spend most of their time at home carrying out domestic duties compared to their male counterparts, who are expected to spend most of the time outside the residential spaces. Therefore, the hypothesis for this study is partially confirmed, meaning that women spend most of their time indoor performing household chores than males. It was also found that the time spent indoor is relatively lower than what is globally reported as known to be >80% of the time, people are said to be indoors. This implies that the variation on the socio-economic status and sub-population including country's dynamic might be the biggest influencer of time-activity pattern. Data obtained from this study can be used to account variability in human health risk assessments and reduce uncertainty in the derived exposure dosage where time spent pattern is considered an important variable.

Recommendations

- ✓ Future studies may be carried out covering a larger population density to gain more detailed time activity patterns.
- ✓ This study focused on a low-income settlement which has different characteristics to semi-formal, rural, high tax yield settlements in South Africa. Therefore, a larger study focusing on different socio-economic classes need to be carried out to have a comprehensive time activity pattern dataset for South African population.
- ✓ The current project focused only on adult age group without considering vulnerable groups (toddlers, and elderly person) time activity pattern. An additional study

focusing on children time activity pattern is required in order to gain an understanding on what activities children spend most time.

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Abbreviations

USEPA:	United States Environmental Protection Agency
SES:	Socio Economic Status
SMS	Short Message Services
GIS:	Geographic Information System
HREC	Human Research Ethics Committee
ABMs	Activity-based models
CHAPS	Canadian Human Activity Pattern Survey
NHAPS	National Human Activity Pattern Survey
HHRA	Human Health Risk Assessment

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CHAPTER ONE – INTRODUCTION

The chapter looked into different setups in all from different communities, looking at the lifestyle, activities that are mostly performed and lastly how often do they spend time doing such activities. The research problem statement, the aim and the research objectives of the study are presented. Lastly, the justification of the study is highlighted.

1.1 BACKGROUND

In recent years, the determination of ethnic/racial and socioeconomic health inequalities remains a significant public health issue (1)(2). One of the main focuses of environmental justice has always been the contribution of the social and physical environments in shaping adverse health outcomes amongst the poor communities of a different race (3). Studies have reported that most people spend more time indoors than outdoors(1) (2) (4). However, there has been a growing concern of pollution of indoor environments often associated with contamination due to the use of chemicals from several household activities (5)(6), including cooking, and outdoor pollutants, which might lead to increased exposure due to time spent indoors (7)(8).

These air pollutants from these household activities are ubiquitous in indoor environments (3). Exposure to indoor pollutants might be linked to negative health effects (6), including frequent colds, headaches, chronic cough, respiratory problems, chronic cough, skin irritation and eye irritation (9). However, the currently available indicators on time-activity patterns are mainly derived from developed countries (3). Research has suggested that databases obtained from high text populations might not be relevant to the South African low-income sub-population (4). Therefore, more attention should be given to determining indoor exposure to household activities since these pollutants not only pose a serious threat to low-income environments but also their health status.

Several studies on human health risk assessments have been carried out to estimate exposure-related outcomes in residential areas (10). However, the risk assessment rating criteria remains incomplete due to the limited data with regards to time spent patterns or activity patterns in developing countries (11). Most importantly, understanding human time-activity pattern is an important aspect of exposure assessment (12); it includes information about the activities undertaken, and time spent in different microenvironments (13). Consequently,

knowing activity patterns indicates possible exposure profiles while time spent patterns assist during dose estimation (14). Information regarding time spent in microenvironments plays an important role during exposure assessment studies for a specific sub-population (15), identifying the exposure sources, where exposure occurs and the extent of exposure (16). Assessing and understanding indoor and outdoor exposures to pollutants (17), physical activity (sitting, sleeping, and walking) is an important parameter to derive an exposure dose (18). Demographics and lifestyle factors also influence time activity patterns (4). In addition, human activities influence location, time and the amount of individual environmental exposure to contaminants (15) (19). However, they depend on the time activity pattern characteristics of the population (5), including the microenvironmental concentration of contaminants or chemicals, which might play key roles in explaining exposure variations (20) (21).

A study by Yang et al. (5) has shown that time-activity patterns in indoor environment are affected by specific work activity, whether the respondents are staying with their children or were living alone at home (22). Season and gender are important factors associated with indoor times (15). Gender, age, educational level, size of the households are used as independent variable , including household that have children (3). For instance, research has pointed out that males have different activity patterns than females during weekends (23), but both genders have the same activity pattern on weekdays (10).

Studies suggested that many people spend 80% of their time in their homes, and there has been rising distress over health concerns influenced by the presence of airborne pollutants in the indoor environment that would enter the human body through inhalation (24) (25)(26) . On weekend, people spend 14.5% of their time in outdoor areas and about 4.8% in their public and private transportations (27). On weekdays, a higher percentage (58.3%) of people spend more time indoors (28). For example, airborne particulate matter can be released from mine dumps into the outdoor environment over time (17). As a result, communities may be exposed to these pollutants on daily basis (5).

Research has shown that exposure to dust from mine dumps may cause adverse health effects (17), particularly in communities living closer to mine dumps, including elderly and children (29). In the low-income settlements, the health effects due to exposure to mine dumps has caused major public concern in developing like South Africa (9). These low-income settlements are mainly characterized by a higher rate of poverty, unsafe neighborhoods,

inadequate housing, less-resourced schools and single-parent households (1). In these neighborhoods, most of the adolescents spend time taking part in outdoor activities, including soccer, burning fires on the street corners and smoking that expose them to outdoor air pollution (30).

Human activity pattern studies rely on data that is used in tracking individual movements and activities travel diary (24). However, gathering information on travel diary data is usually laborious and expensive (7). Time activity patterns are used in epidemiological studies and exposure assessments, to gather information on various microenvironments (20). In addition, Huang & Wong (7) used cell phones to acquire data on human time spent in a specific location (in the boundary/ outside the study boundary.

1.2 LITERATURE REVIEW

1.2.1 Time activity patterns

Activity pattern is referred to as a system for all the activities performed, by itself or together with other activities, with the aim of achieving a more general goal. The data from the time activity is utilised as the key factor to determine the environmental exposure to a contaminant during exposure assessment modeling (31). Exposure assessments at population-level require the distribution of time-activity pattern in association with to environmental setting, including where individuals live and spend most of their time. In addition, time activity may be influenced by the societal trends as it was observed Canadian data collected in almost fifteen years ago (32)**.**

Time/activity diaries have been utilized in the past and present; therefore they have history in understanding human activity patterns (23). In addition, time/activity diaries have been utilized in Epidemiological studies, to assess the exposure to in order to identify the uses of microenvironments, including gathering quantitative and qualitative data on activities that contribute to an individual's exposure to activities that they carry such as smoking habits, frequency, and duration of cooking activities. Some of the diaries are made up of two parts: a time budget and a timeline. The timeline describes how the person's use of space during the day at home, at work, and in transit, giving more information about the specific microenvironments such as at home outdoors and at home indoors. The number of locations the timeline is divided into, depends on the study's objective. The choice of the locations in

the easiest form is at home or not at home, subsequently, the choice of locations will depend on the study, and the community in which the study is conducted (20).

Activity patterns can be observed in different settings, including individual level, population level or group levels and household level. (33). Activity pattern is recognized as an activity performed activities aimed at achieving more than the general goal by the individual (34).

During the analyses of data collected with diaries in a day, activity patterns identified in one respondent (referred to as an individual activity pattern) are highly unlikely to be significant but those found in groups or population (a collective activity pattern) are of greater interest (35). In a collective activity pattern one can detect the various combinations of activities aiming to achieve the same goal and study the characteristics of the individuals performing them (36). Similar combination of activities can also be detected for many individuals in a population or combinations that occur commonly in a population and then more closely study the similarities of these individuals (37).. Collecting information on activities using in a larger population through time can result in a large amount of data that may be difficult to understand at first glance (38). Studying the time diaries can be a time-consuming activity; trying to observe similar patterns within them takes even longer. An advantage of doing visual representation of the time diaries in this regard is that images are easier to interpret than the lengthy columns of figures and text of the time diaries (39).

Human exposure and intake of environmental contaminants require that people spend time in contact with the agent (32). The microenvironment includes total time spent in vehicles, indoors and outdoors indoors (40). The time line identifies the space used by individuals weekly at work, in transit, including at home, () Therefore it provide adequate information in concerning specific micro-environmental settings, including at home. (20). Research suggested that the pattern of time activity is significant for risk management and exposure assessment (41) (42). Time activity is identified as crucial for personal exposure to pollutants that include air pollution (41). Data from the time activity is important information to be used for exposure assessment models in determining the environmental exposure to contaminants (12).

Time activity patterns might be influenced by different factors that include lifestyle, demographic, age, gender and day type, season (winter/summers) (5) (16). Moreover, personal factors that promote exposure are personal residential location, background pollution concentrations and area classification (i.e. rural, suburb, etc.) (13). The consideration of time-activity patterns has a crucial

effect on many processes that include planning and decision support (43). The concentration of pollutants coming from the microenvironment are combined with information obtained on time in a geographical area, including producing estimated time weighted exposure based on the breathing rate during a specific activity (44) (45). Assessments of time-activity patterns that are not accurate may lead to misclassification of exposure (20). The daily time-spent in different environments serves as an important attribute that can be utilized to obtain individual exposure to chemicals that are airborne. Even with current significant numbers of time activity pattern studies carried out, there are limited studies undertaken in different countries where the climate recognized as extremely cold, including the North Europe information, the amount of research done on this topic is rather limited more especially in North Europe where the climate is rather cold.

1.2.2 Time spent indoor and outdoor

In the USA, majority of individuals spend about 90% of their time in the indoor environment (46). According to *Yang et, al*(5) people in China spend about 86% of their time indoor. However, people in Germany spent on average 65%of their time indoor; male account for approximately 61% minutes indoor, while females account for approximately 69%. In Chongqing, people are found to spent majority of their time indoor in their bedrooms. Moreover (47) conducted an analysis of the time spent indoors at home in Germany. The mean time spent at home was equal to 942 min (65%) with more values for women (996 min, 69%) than their male counterparts (882 min, 61%) (48)**.** In a one-day average, individuals from Chongqing spent the most time at home in bedrooms and other people spent more time at home but less in outdoors (47)**.**

1.2.3 Gender and Age as influencing factors on the time-spent pattern

Females are usually responsible for different activities, including domestic household activities, and caregiving for children and the elderly compared to males (49). Consequently, it is found that males spend less time at home indoors than females in Finland (10). In China, female adults spent more time in kitchens, bedrooms and offices compared to males (50). Physical activity is found to be associated with time spent outdoor in particular to youth, including older adults (51). Subsequently, older children outdoor time was found to be associated with their physical activity. . According to the study by Gray *et al*., (51), outdoor time was related to physical activity levels for older children (52). In addition, the authors

revealed that children are physically active when they are in the outdoor setting compared to indoor setting (52).

In a rural setting children are found to spent more time outdoor (32). In farm community children are found to spent majority if their time indoor (53). However, old age individual are compared to other age groups are expected to spent less of their time outdoors (51). However, adults in Korea are expected to spend more time in in transit on the traffic congestion compared to youth and old age people due to gradual activities. (5). However, in Helsinki, people are found to spent more time indoor than outdoor, irrespective of their age difference (54). A study conducted in Durban revealed that more time is spent by adult inside their homes (55). In addition, adults are found to spent more time inside the vehicle (12). Subsequently, in China, adolescents and adults are found to spent more time in transit or indoor working or studying (50).. The youth spent most of their time in "classroom" and less in "outdoors" than adults, since most teenagers received compulsory education (56). Adults spent are more time working in "outdoors". Senior citizens spent most time at home ("living room", "bedroom", and "kitchen") (55).

1.2.4 Time spent cooking indoor/outdoor

While combustion products may be global, other people have greater exposure than others depending on their location of settlement. Exposure of individuals to combustion products is influenced by cultural and socioeconomic status (SES) factors. These factors include the location used for heating and cooking facilities, the mechanisms of heating and cooking fuel, use of motor vehicles, smoking habits, distance to the roads and industrial sites, and occupational activities and recreational facilities (57).

1.2.5 Time spent on recreational activities indoor/outdoor

Research has shown that males and younger children spent more time outside playing, compared to other demographics groups accounting for 84% of the respondents. The result of the study also suggested males, younger children spend more time in other activities such as jogging, biking or running (65). Recent research has suggested that all the physical activity undertaken in natural space in the environment and outdoors environments (sometimes termed "green exercise") may add positive benefits, which includes improving the mood, mental health and self-esteem, feelings of revitalized, feelings of energy, and social unity, and decreased confusion, stress, mental fatigue, tension, depression and anger. For instance a study by (27) have found

that time spent outdoors is mostly associated with lower chronic disease risk. It further indicated that while these associations are not fully explained by activity levels, controlling for activity levels does not reduce the relationship between time outdoors and chronic disease risk.

1.2.6 Time spent pattern with respect to socioeconomic and occupation

There is a significant difference between the time spent outdoors in their microenvironment and activities by urban and rural residents (32). In developed countries such as Europe, individuals that work far away from their residential areas and who are more educated are found to spend less time indoors at home (40). Most people staying in the rural setting are employed in farming (agriculture) environment, including hunting and faming. As a results, there are most likely to be exposure to adverse environmental conditions that include outdoor air pollution emissions due to diesel-powered.

In addition, the population in the rural environment or communities are more frequently reported to be spending their time near gas- or diesel-powered equipment (32). While the population in the urban setting is exposed to vehicles diesel or gas emission (31). With regards to their routine work, the adults that are employed, spent most of their time at work (58). The employed adults spent less time outdoors than the school children (57). Adults spent more working time in "outdoors (55). People with higher education spent less time in "outdoors", "kitchen" ,and" other indoors (59). The time spent in "office" by people who have the highest education level (tertiary) was 7.8 times greater than that by people with the lowest level (primary school or illiterate) (55). People who earn more spent less time in "outdoors", "kitchen", and "other indoors" but more time in "office" and "living room" (56).

1.2.7 Time spent pattern with respect to seasonal differences and weekdays

During warmer seasons most people are found to spend most time outdoors than during the winter season; as a result, less time is spent in the outdoor environment (10). In Camden, people were found to spend most of their time at work on weekdays during winter than summer (2). Subsequently, people in China spent most of their time indoors on weekdays than on weekends on average (50). While in Eastern Mediterranean student males are found to spent more time outdoor during working days than females (10).In addition, studies from Camden and America found that people spent more time indoors during weekends than during weekdays (2)(46). In Korea, majority of the people are not working during weekends;

therefore they spent less of their time in transit during the weekends compared to weekdays (5). Moreover, in Finland, people spent most of their time at home on weekends than during the week/workdays reason being that the majority of our subjects did not have work on weekends (60) .

The unemployed adults spent more time at home on winter weekday (2). Time spent in the microenvironment at home was the largest mean proportion for all the groups, with overall mean percentages of 65.4% in the summer and 67.5% in the winter (23). People spent more time at home indoors in winter than in summer (56). People in rural areas spent more working time in "outdoors" (mainly on the farm, with the highest 40% at 15:00–16:00), meanwhile people in urban areas spent more time in classroom/office (56). Canadians spend less time outdoors in winter and less time indoors in summer than their U.S. counterparts (54). When exposure assessments use outdoor/indoor or time of the year exposure, they may result in significant differences in exposure assessments. Otherwise, the 24 - h time activity patterns of North Americans are similar and use of the data that is combined set for some exposure assessments may be feasible (61).

1.2.8 Time spent commuting to work

People living in rural areas have to travel longer distances to their working places (62). The rate of women who are employed outside of the neighborhood is higher in the rural areas (62). People who are employed full time spend more time in transit than people who are unemployed (63). More than half of the school going children and adults that are unemployed are reported spending no time in vehicle (2). The total time spent used in transit was reasonably constant and equal to about 64 min (4%) and 96 min (7%) for homemakers and full-time workers, respectively (63). Rural people spent less time in indoor environment " (63) Males spent more time in "outdoors" and "transit (23). Overall, commuting in the NCR is dominated by the use of non-motorized transport, followed by buses and two-wheelers (62). Among the urban areas, the use of cars and buses is the highest in Delhi, which could be related to high incomes in the core of the region and a well-developed system of public transport in Delhi (20). Compared to urban areas, in rural areas, the use of cars is much lower, and the use of buses is higher. The dummy for rural areas has a significant positive impact on the proportion of public transport, whereas it is negatively related to the proportion of non-motorized modes, moped and motorcycles as well as to the proportion of cars (5)**.**

1.2.9 Tools used for data collection

Questionnaires and surveys tools are used to gather scientific data in relation to the groups of individuals and households in neighbourhoods. Therefore, the data collected will be utilised to produce statistical data of the individuals or household that took part in the study /survey (63). The tools (questionnaires or surveys) maybe administered in a form of person interview with the participants or telephonically, including completion of written questionnaires.in addition, majority of survey tools are utilised in population or community-based studies where the results will be generalized to the population in which the sample was taken from. Surveys data collection includes information such as demographics (i.e. age, gender, race, occupation, distance to highways) (20)

Diaries are utilized to record comprehensive individual's data concerning performance during a particular task. The tool is commonly used for collecting time activity data in research. In addition time activity data gathered use dairies, include a vast and complex database that can be student and interpreted. There are several approached that can be utilized to interpret and analyse the data collected using diaries in research that include statistical analyses (20). Activity dairies play a big role as a data collection source for many studies, dataset records activities conducted by individuals that are participating in the study within a given period (20), it includes information such as the time the activity commenced and concluded, the place the activity took place (74), individuals who participate in the activities and characteristics of those activities (75)(76). Communication was used in a form of short message services (SMS) was sent to the participants to remind them about the completion of the diaries on time. As a result, a total number of 20 diaries were completed. The results using this method are viewed as easy to summarize, generalize and compare (35).

1.3 Problem statement

Methodologies for human health risk assessments are insufficient in determining human exposure and the associated health effects (16) (64) .Moreover, the studies on human health risk assessment did not consider variations amongst individuals, especially on time-activity patterns and geographical locations (2). Therefore, the omission of time-activity patterns leads to increased uncertainties on current risk estimations in exposure assessment (12). Existing data on time-activity patterns use benchmarks or default values in health risk

assessments, using populations from developed countries with limited or non-existent data for the African population, and South Africa is no exception.

Most studies (11) (65)(66) have focused on the use of probabilistic risk assessment for risk estimation. In many of these studies, existing time spent patterns/ time activity patterns were used as default values adopted from the United State Environmental Protection Agency (USEPA)(67). Although it has been suggested that people spend 90% of their time indoors (40), it is anticipated that this information might not be relevant for South Africa, where there are different sub-populations (Urban formal, urban informal and rural settlements). Critical aspects on a time-activity pattern found in the literature are incomplete and do not address time spend watching TV, cooking, bathing, sleeping, walking, and commuting, which are essential for exposure assessment (68). Research on time activity or time spent patterns did not provide details on activities an individual undertakes indoor and outdoor on daily basis. In developing countries, data on health risks associated with air pollution exposure is less documented (68). Effective measures to ensure completeness of exposure dose estimation are important (9).

Time-activity patterns in urban South Africa have not been adequately explored, including the associated health risks. No in-depth and systematic analyses of time-activity patterns in low-income communities have been done in South Africa. Therefore, there is a paucity of research on how much time people spend indoors and outdoors in the South African context. In this study, time activity and spend patterns in urban South Africa will be investigated, focusing on low-income communities residing next to mine dumps, using diaries. Such information may help reduce uncertainty on risk estimation and exposure assessments, and provide additional information during exposure assessment, especially when data obtained using ambient air monitoring stations are used during risk assessments.

1.3.1 JUSTIFICATION

The results could add to existing growing body of evidence on time activity patterns especially in the context of informal dwellings. The study could generate information that might be necessary for the development of an exposure assessment handbook in South Africa, and generate ground base information, which may be necessary for inclusion in the current existing risk assessment framework. The study may provide information on understanding time-activity patterns in South African urban settings.

From a policy perspective, this study can assist in policy formulation and development of standards and risk assessment methodological and parameter considerations in deriving human exposure dose. For the first time in the South African low-income setting, an effort to describe and determine activity and time spent pattern study was explored. Exposure is influenced by the concentration of a concerned pollutant, behaviour of the receptor and the exposure duration. Therefore, the completeness of exposure dose determination of all variables needs to be carefully characterised and used in dose estimation calculations. This study is of significance being the first in the South African context aimed at describing a variation on time-activity patterns according to age, sex and economic status amongst residents of low-income communities in South African townships.

1.4 STUDY AIM

The study aimed to describe variations on time-activity patterns based on age, sex, and socioeconomic status amongst residents of low-income communities in South African township (Matholesville informal settlement)

1.5 OBJECTIVES

To achieve the above aims the following objectives were set out:

- To investigate time activity pattern amongst different age groups in low-income communities in Johannesburg township (Matholesville informal settlement), South Africa;
- To determine time activity pattern in different sex in low-income communities in Johannesburg township (Matholesville informal settlement), South Africa;
- To examine the effects of socioeconomic status on time activity pattern amongst residents.

CHAPTER TWO-METHODOLOGY

This chapter begins with a comprehensive description of the study area and time activity patterns in different microenvironments. The chapter further provides the methods and materials used in the collection of data. The chapter ends by providing the data analysis methods for each objective of the study.

2.1 RESEARCH DESIGN

This was a cross-sectional study that used a quantitative approach whereby we aimed to describe variations on time-activity patterns based on age, sex, and socioeconomic status amongst residents of low-income community in South African township (Matholesville informal settlement). Cross-sectional research design is a type of observational study design (69). In the study, the investigator measured the exposure in the participants concurrently. In a cross-sectional study, the investigator measures the exposures in the study participants at the same time. The study was cross-sectional study. (70).

2.2 METHODS AND MATERIALS

2.2.1 Description of the study area

The study was conducted in Matholesville informal settlement located in the City of Johannesburg region C, Gauteng Province. Figure 1 shows the aerial map of the study area. The total population of Matholesville was estimated to be 14,905; with 6,433 households. The area's land coverage is about 1.30 km^2 (71). It is located on 26°9'22"S and 27°53'8"E. The area lies 1775m above sea level, with a warm climate and rainy in summer compared to winter, and an average annual temperature of 15.5 °C. The driest month is July, and the greatest precipitation is experienced in January, with an average rainfall of 144 mm. The minimum temperature in January averages 19.8 °C (71).

The study population were the residents of Matholesville informal settlement. However, about 17% (745 houses) of households are informal settlements. Informal settlements are mainly characterized by inadequate amenities such as poor housing units. These units do not comply with building regulations and insufficient basic services (64). The area is occupied by 98% black Africans. The most common language is Setswana followed by IsiXhosa and Xitsonga. The population age group is mainly between 20 to 35 years.

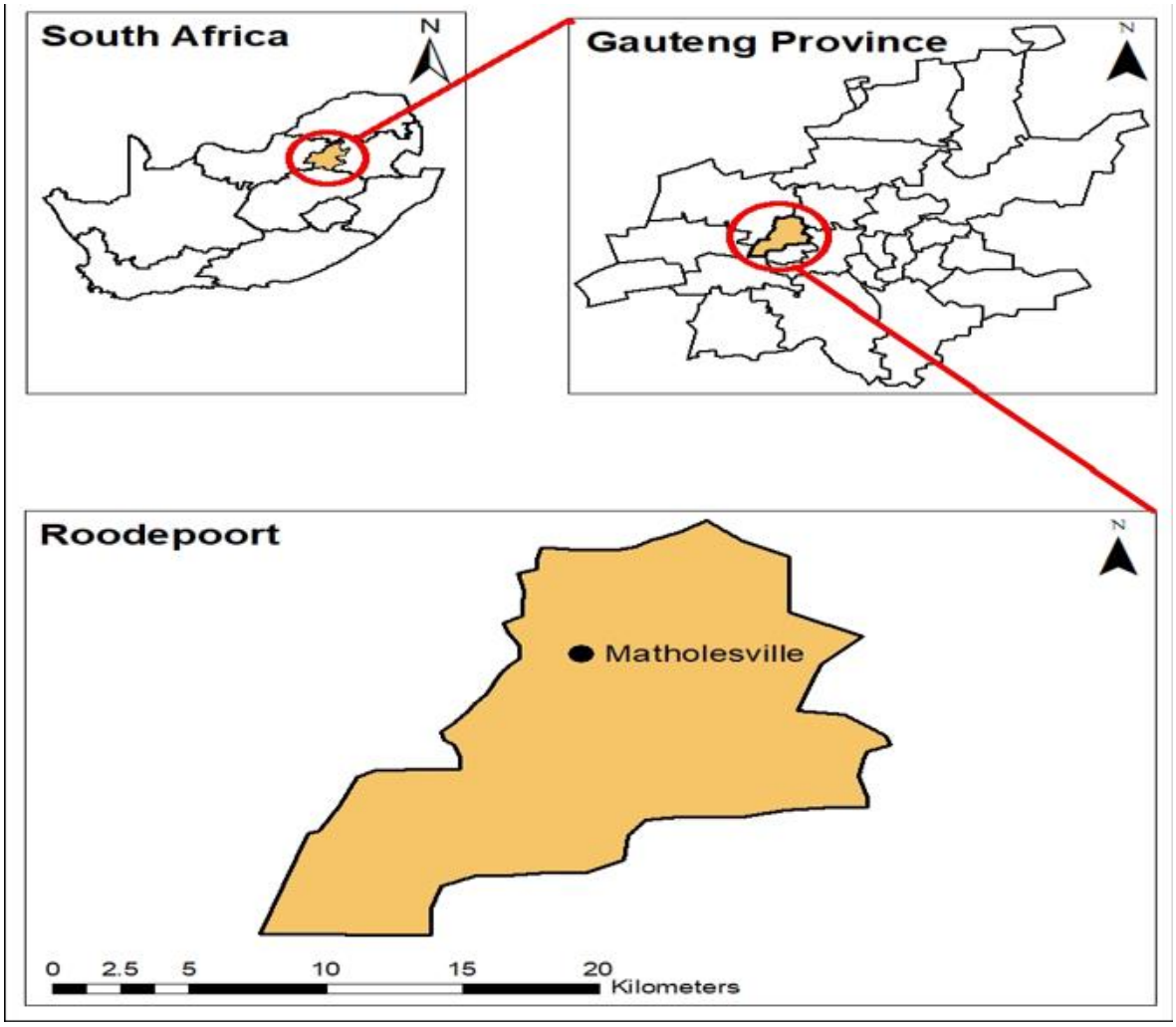


Figure 1: A geographical map of the study area (Created using ARCMAP GIS version 10.8 and google earth map)

2.2.2 TARGET POPULATION

The target population was from the informal settlements described above because they were accessible to the researcher, which consisted of 130 respondents, which constitute 20% of the study population.

2.2.3 Sampling

A purposive random sampling technique was used to select the study participants. This involved doing a door-to-door approach. Representative respondents were considered by roles (residents), and/or diversity (gender, ethnicity, and occupation).

2.3 DATA COLLECTION

2.3.1 Questionnaire and diaries

Questionnaires and surveys, can be used to collect individual exposure, including focus groups, observations and diaries. Subsequently there are about four instruments (i.e. questionnaires, observation, diaries and focus group.) utilised to collect data on sources of exposure, locations and durations of exposure can be obtained with these tools (20). However, the method to be selected to collect data on exposure depends on the study designs and the conditions under which the data is collected (72). The type of instrument to be used depends on several factors that includes the degree of participant burden that is acceptable, and available resources for this aspect of the study (73).

Data was collected using two instruments which are questionnaires and diaries. Data was collected using questionnaires consisting of close-ended questions. Questionnaires were developed, and distributed to be completed by the participants. The questionnaires were based on time-activity pattern and were divided into sections which are Socio-demographic (such as age, status of employment, gender, educational level and season of the year) and other section looks into questions on types of activities done at home such as watching TV, cooking, cleaning, and how much time spent on each activity . For detailed questionnaire refer to annexure One. The participants were randomly selected, random selection was done so to not look bias in the community. The questionnaires were filled in the presence of the researcher and were collected immediately. The study respondents were limited to answer by selecting from the list on the questionnaire or by yes/no. The questionnaires were administered by the project principal investigator (PI). One member per household was selected to participate in the completion of the questionnaires. Questions were divided into sections according to the study objectives. The respondents were restricted to a few answers from a questionnaire and logbook/ diaries. A total of 130 questionnaires were administered by the researcher.

Diaries

A total number of 20 diaries were completed by 20 respondents. Seven days diaries were distributed amongst 20 respondents. The 20 respondents that completed the diaries also participated in the questionnaire studies to calibrate the information for the questionnaires. Diaries were self-administered by the study participants were they completed their time spent

in various microenvironments for seven days. Diaries were divided into four activity areas which includes indoor and outdoor microenvironment, in vehicle with open or closed windows and church. For more detailed information on diaries refer to annexure two.

2.3.2 PRE-TESTING OF DATA COLLECTION TOOLS

A pilot study was conducted with 10 respondents check the usefulness of the questionnaires instruments. Conducting a study is crucial to test the tools reliability to collect data before the actual study project. (77). The 10 respondents who were selected for the pilot of the data collection tool were excluded from the main study population to reduce bias. A pilot study test the feasibility of you data collection tools, also check if the respondents understand the way the questions are structured and to check if the information collected meets the objectives. Moreover, a pilot study also has a particular design feature; it is piloted on a smaller scale than the full or main scale of the study. In other words, the pilot study is important for guiding and improving the quality and efficiency of the main study.

2.3.3. Data processing and analysis

Data from diaries and questionnaires was transferred into Microsoft Excel sheet for analysis. Data was presented using descriptive statistics and frequency tables and graphs. Descriptive statistics includes summarizing and organization of the data so that it can be easily understandable. In addition, descriptive statistics describe the data, but does not try to make interpretations from the sample to the whole population (30). Therefore, frequency tables and figures were used as a method to organize s data in a compact form by showing a series of scores in ascending or descending manner, together with their frequencies.

The data analyses included demographic and technical data such as age, status of employment, gender, educational level and season of the year. Data from individual exposure provide an excellent demonstration of human activity patterns, including personal exposure to environmental contaminants or chemicals.

2.3.4 Response Rate

About 98% response rate was achieved, which is viewed as satisfactory, unlike when collecting data using survey monkey, online or via emails. This was statistically significant sample, as it surpasses the required response rate of 30%.

2.4 ETHICAL CONSIDERATION

Ethics was obtained from the University of the Witwatersrand Human Research Ethics Committee (HREC) before data collection (ref no. M210209). The study was a stand-alone project. A request for approval to conduct the research at the City of Johannesburg Metropolitan, Region C was obtained from Region D councilor. Permission was sorted from the City of Johannesburg, including the ward councilor from the study area. Data obtained was stored and only accessible to the principal investigator of this study.

A community meeting was arranged through the ward councilor for the researchers to inform the community members (respondents) about the study. The study respondents were informed that participation was voluntary, without any benefits or penalties, depending on their decision about study participation. The study participants were given the information on the research study and consent forms, the process was thoroughly explained to them. There was no penalty or victimization for refusal to participate in the study. It was voluntary and this was explained to them. Informed consent was given to the respondents, and they were informed about the study aim and their rights to withdraw at any time during the data collection process should they feel uncomfortable continuing.

The respondents were requested to sign the consent forms. The questionnaires were administered by the researcher and diaries were only self-administered by the respondents to characterize time activities patterns after informed consent has been obtained. The questionnaires and diaries were provided with unique identifiers instead of using the name of the respondents or details that can be used to trace back to the respondents to ensure anonymity and confidentiality. All data capturing sheets are stored in a lockable room and electronic versions of the sheets are encrypted with a password known only by the principal investigator.

3. CHAPTER 3 RESULTS

This chapter gives an overview on, research findings, data analyses and interpretation of the results from 130 questionnaires completed by residents of Matholesville South, Johannesburg South. Microsoft Excel Package was used to analyze the data. This chapter presents the study results o based on the study objectives. It focuses on time-activity pattern of the community of Matholesville. The following variables were analyzed: Socio-demographic data, gender, race, age, education, employment status and season. Data was collected, cleaned, double-checked to ensure accuracy, properly categorized, and converted to match data analyses based on the objectives of the study. The findings are all presented on the four sections of the questionnaire, which are, socio-demographic and time activity. The findings. Based on the findings, human activity patterns are important in identifying and determining human exposure to environmental pollutants. In this study, several factors viewed as having an important effect on time-activity patterns, include age, gender, season, and type of dwelling status.

3.1 DEMOGRAPHIC PROFILE OF THE RESPONDENTS

Information on socio-demographic characteristics was collected, and analyses were performed on age, marital status, race, sex, family size and nationality. Table 1 shows the demographic profiles of the respondents in Matholesville South based on age, education, marital status, education, employment, and time spent. The result in Table 1, shows that most of the respondents residing in shacks were single. Meanwhile most of the respondents in the brick type (RDP) were married. Based on employment status, the results in Table 1 shows that most of the respondents living in the shacks were unemployed while more respondents in the brick type dwellings were employed. Concerning smoking habits, education and times spent (outdoor and indoor) of the respondents, there was not much difference both for residents living in the shacks and brick type houses.

Table 1: Demographic profiles of respondents from Matholesville South

Variable	Shack	N	%	Brick	N	%
Age	18-35	65	65	18-35	10	33
	36-70	35	35	36-70	20	67

Gender	Female	68	68	Female	18	60
	Male	32	32	Male	12	40
Marital status	Single	61	61	Single	13	43
	Married	39	39	Married	17	57
Education	Primary	29	29	Primary	5	17
	Secondary	71	71	Secondary	25	83
Smoking	Smoker	59	59	Smoker	11	37
	Non-smoker	41	41	Non-smoker	19	63
Employment	Unemployed	63	63	Unemployed	16	53
	Employed	37	37	Employed	14	47
Time spent	Outdoor	69	69	Outdoor	20	33
	Indoor	31	31	Indoor	10	67

3.2 RACE CATEGORIZATION OF THE STUDY RESPONDENTS

Table 2 shows the race categorization of respondents. Most of the respondents (75%) were black followed by coloured (14%) and Indian (8%). Meanwhile the white people were the least (2%). All race categories were represented in the study.

Table 2: Race categorization of the study respondents

Race distribution		
Variable	Number	Percentage
Black	98	75%
White	3	2%
Indian	11	8%
Colored	18	14%

	130	100%

3.3 INCOME SPER HOUSEHOLD

The income per household at Matholesville is presented in Table 3. The average household income was R4 304 for those employed and living in brick houses while for the shack type house was R3 650.

Table 3: Income per household [Shacks and Brick type]

House type	Variable	Minimum	Maximum	Average
Shacks	Employed	650	6500	3650
	Unemployed	350	2900	1360
Brick	Employed	1900	8200	4304
	Unemployed	350	2900	1520

3.4 SOURCE OF ENERGY USED BY THE RESPONDENTS

Figure 2 shows the source of energy for space heating, boiling water, lighting and cooking of the study respondents residing at Matholesville South Africa. Based on Figure 3, it can be found that the majority (40%) of the respondents use kerosene followed by electricity and gas. Meanwhile, 8% of the respondents use coal.

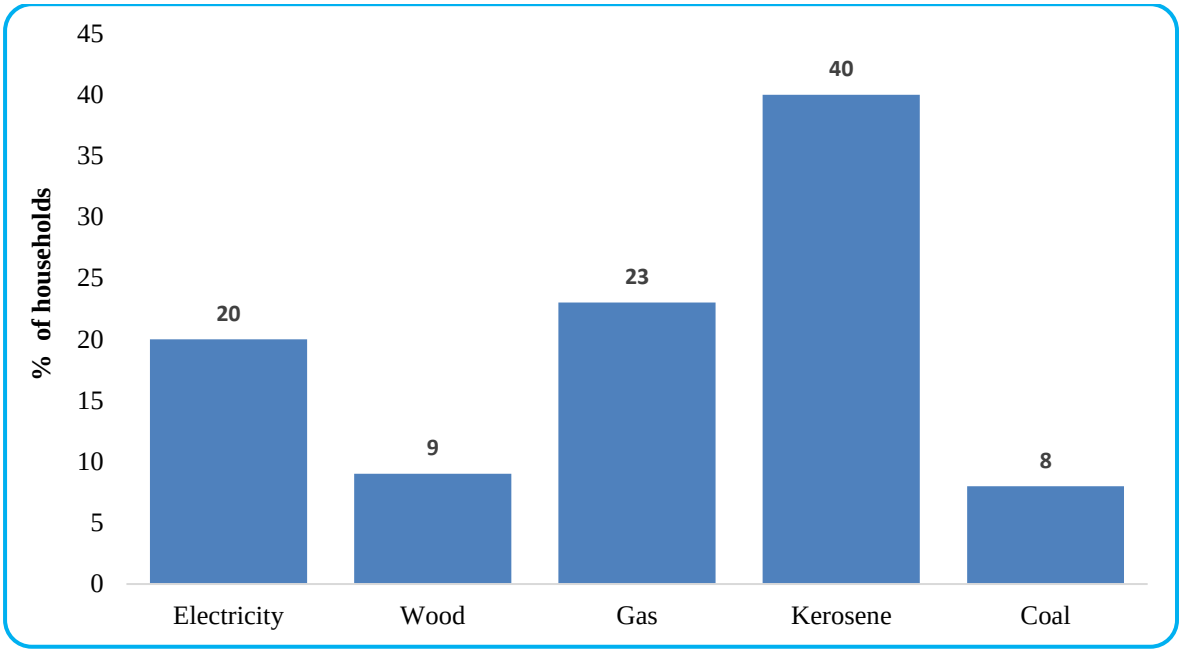


Figure 2: Sources of energy used by the study respondents residing at Matholesville South

3.5 MODE OF TRANSPORT USED BY THE STUDY RESPONDENTS

As shown in Figure 3, most of the respondents (56%) walk to work followed by using public transport (51%) while fewer respondents use private transportation to commute to work.

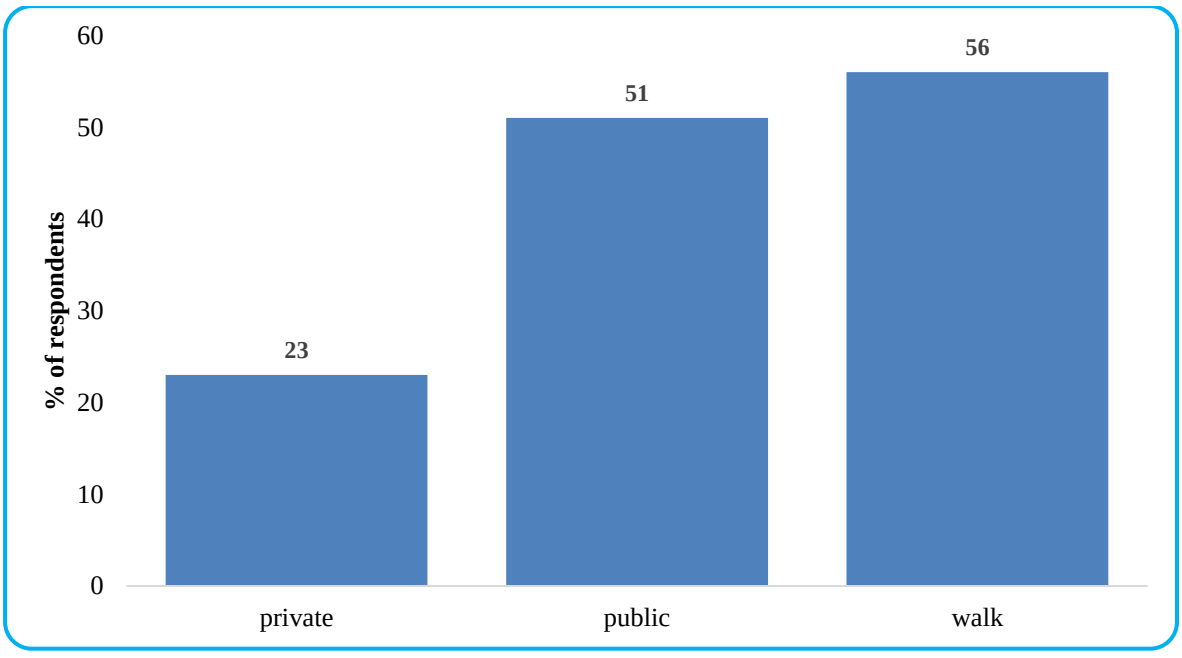


Figure 3: Mode of transport used by the study respondents at Matholesville South Africa to commute to work

3.6 TIME SPENT COMMUTING TO WORK BY THE RESPONDENTS

Time spent commuting by walking, private and public transport was investigated. Based on Table 4, the average time spent by respondents from shacks and brick type household was almost similar for walking (20mins). The only difference noted was walking to work for both household, 45 mins and 30 mins for shacks and brick type house, respectively.

Table 4: Average Time spent commuting to work by the respondents

Commuting to work	Shacks	Brick
Walking	45 mins	30 mins
Private	12 mins	10 mins
Public	20 mins	20 mins

3.7 INDOOR ACTIVITIES DONE BY RESPONDENTS

Concerning the indoor activities performed by the respondents, the following question was asked: "*What activities do you do when you are home*?" Table 5 shows the indoor activities that respondents performed in their house in Matholesville. The predominant activity performed by the respondents was cleaning followed by sleeping and cooking. The results of the study showed the dominant activities in shack household, are in order of cleaning > cooking > sleeping. From the findings in Table 5, in the brick type household, the dominant activity is sleeping.

Table 5: Indoor activities done by respondents

Activities	**% Shacks**	**% Bricks**
Watching TV	37	60
Cooking	70	77
Cleaning	87	70
Sleeping	68	100

Playing outside	59	63

3.8. TIME SPENT

Most of the respondents living in the shack house spend their time outdoor (69%), compared to the respondents in the brick house (67%) as shown in Figure 4. Most respondents in the brick house spent their time indoor (33%), compared to the respondents in shack house (31%).

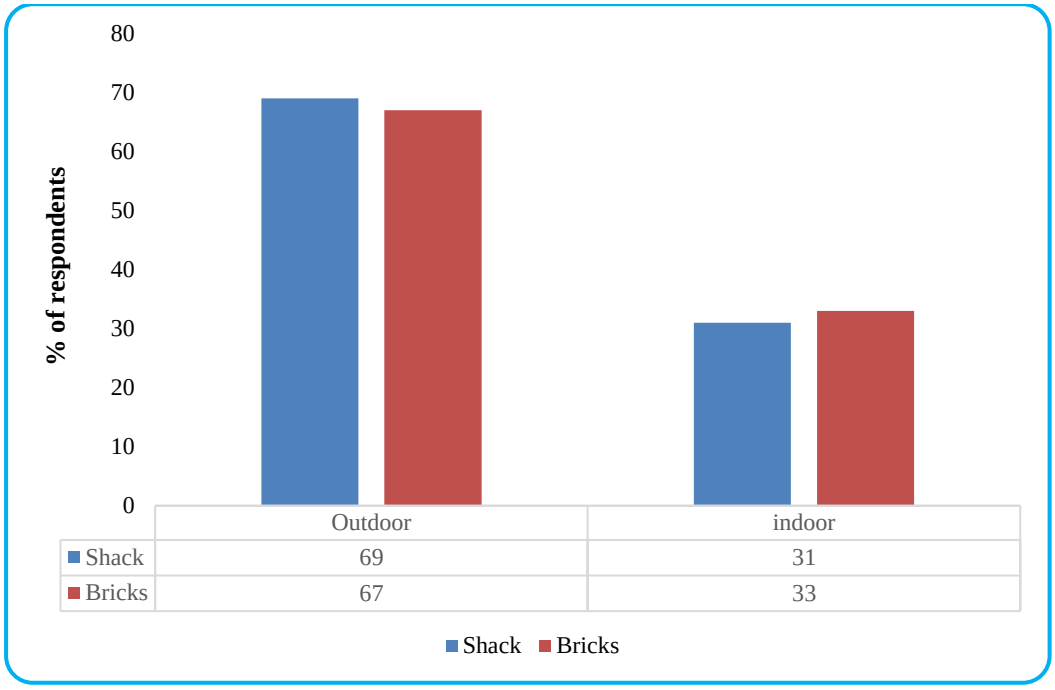


Figure 4: Time spent pattern for shack and brick dwellers

3.8.1 Time spent on indoors activities

In terms of the time spent indoors, respondents, were asked the following question "*How much time do you spend on these activities*". The responses to this question from the respondents in Matholesville are shown in Table 6. Based on the findings in Table 6, it can be shown that the respondents in the brick type household spend more time indoors watching TV (3hrs), compared to the respondents living in the shack type household who spend 2hrs on the same activity. Regarding cleaning, the respondents in the brick type spent more time than those living in the shacks. In terms of cooking and sleeping, the respondents in the brick type household spent almost similar number of hours in these activities.

Table 6: Time spent indoors by the respondents

Activities	Shacks	Brick
Watching TV	2 hours	3 hours
Cooking	4 0min	45 min
Cleaning	1 hour	1 hour 30min
Sleeping	7 hours	7 hours

3.8.2 Time spent outdoor

Figure 5 illustrate the total percentage (%) of respondents spending time outdoor, and time spent on outdoors. The respondents spent less than 8 hours outdoors, with those from the shacks spending 5hours , 2 more hours compares to those from brick houses . Respondents living in the shack type house spend more hours (5hrs) outdoors accounting 62 % while the brick type house spent less time outside (3hrs) (38%).

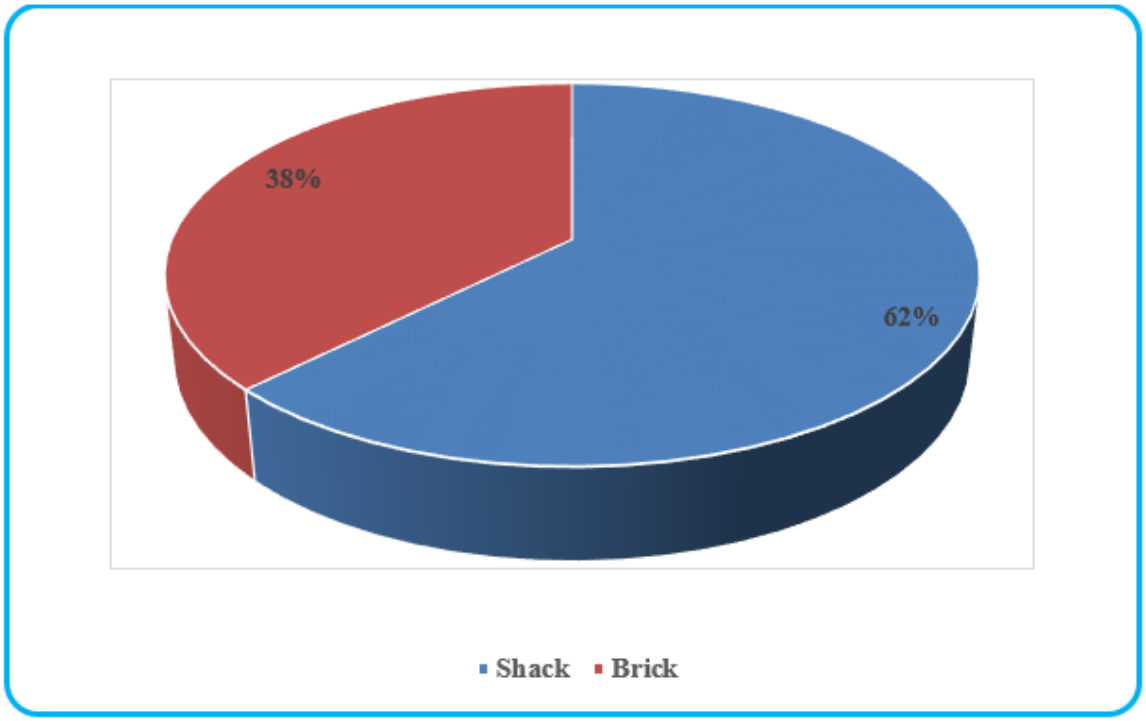


Figure 5: Time spent indoors by the respondents

3.9 SEASON PREFERENCE AND TIME SPENT PATTERN

3.9.1 Seasons and time spent patterns

Respondents were asked to state the season of preference and time spent pattern. **Error! Reference source not found.** and Table 7 show the season preference and time spent pattern in both shack and brick houses. Table 7 shows season of preference per household type. Based on Table 7, it can be observed that respondents in the Shack preferred summer season compared to their brick houses counterparts. It can be noted that in winter, respondents in bricks houses preferred winter season as compared to respondents in shack houses. The majority of the respondents in the shack houses spent most of their time outdoor during summer season (10 hours) compared to winter season (7 hours).

Table 7: Season of preference by the respondents

	Variable	N	Shacks	Brick
Preferred season	Summer	107	72(67.3%)	35(32.7%)
	Winter	23	9(39%)	14(60.87%)

3.9.2 Time spent indoors and outdoors by the respondents

In the study, the respondents were asked about time spent indoors and outdoors. Table 8 below presents time spent indoors and outdoors by the respondents in shack and brick type houses. Respondents in shack houses spend eight (8) hours indoor in summer while respondents in bricks houses spent ten (10) hours indoors. There is no variation between the time spent outdoors in summer and winter by the respondents in shack and brick type houses.

Table 8: Time spent pattern by season

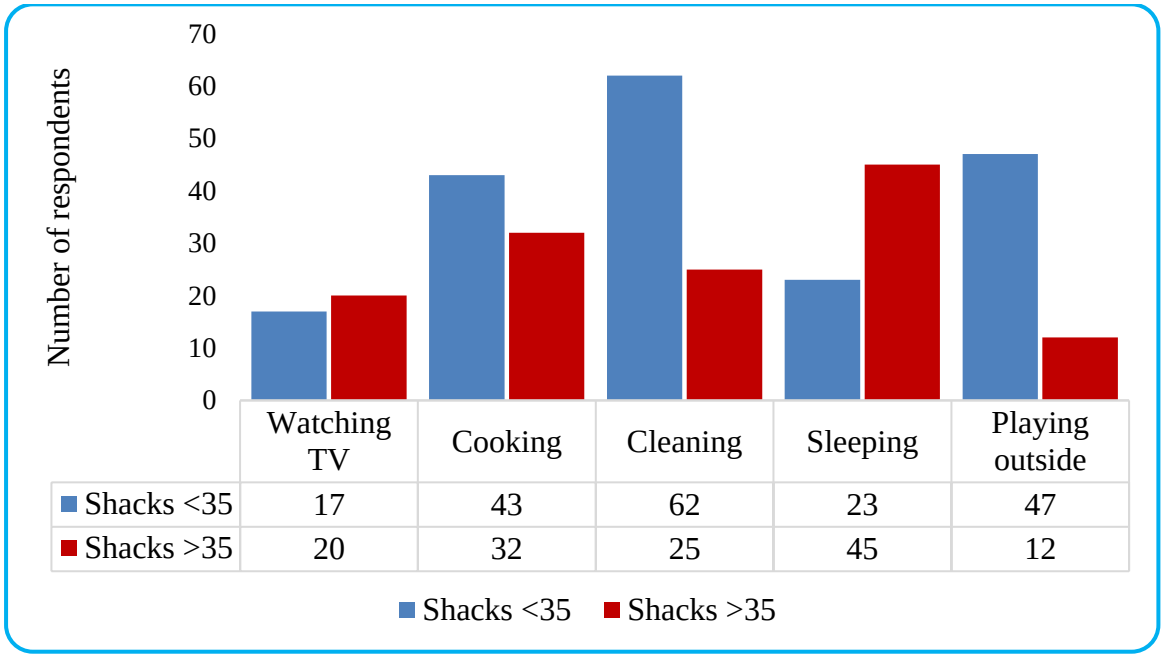
	Summer	**8 hours**	**10 hours**
Time spent indoor	Winter	11 hours	11 hours

Time spent outdoor	Summer	10 hours	10 hours
	Winter	7 hours	7 hours

3.10 A COMPARATIVE EVALUATION OF ACTIVITIES ACCORDING TO THE HOUSE TYPE

3.10.1 Age, and activity in the shack house type

Age and time activity patterns for the respondents in Matholesville were investigated as illustrated in Table 5 and Table 9. Figure 6 illustrates age and activity patterns in shacks. Most respondents aged <35 living in the shack spent more time in the house cleaning, cooking, watching TV and sleeping compared to the respondents in age group >35.



	Watching TV	Cooking	Cleaning	Sleeping	Playing outside
Shacks <35	17	43	62	23	47
Shacks >35	20	32	25	45	12

Figure 6: Age group and activity patterns of respondents in the shack household

Table 9 shows age and time activity pattern of respondents aged <35 and >35 living in shacks houses. Respondents aged <35 spend less time watching TV and compared to respondents aged > 35 years of age. Respondents aged <35 and >35 spent the same amount of time cleaning. The result further showed that respondents aged <35 spent more time outdoor as compared to the respondents aged > 35.

Table 9: Time activity patterns of respondents (<35 and > 35 years in shacks)

Activities	less than 35 years		More than 35 years	
	Number	**Time spent**	**Number**	**Time spent**
Watching TV	17	1 hour 30min	20	2 hours
Cooking	43	35 minutes	32	45 minutes
Cleaning	62	1 hour	25	1 hour
Sleeping	23	7 hours	45	8 hours
Playing outside	47	5 hours	12	3 hours

3.10.2 Age, and activity in the brick type house

Figure 7 and Table 9 illustrate age and activity patterns of the respondents living in brick type houses. Most of the respondents living in the brick type houses, aged <35 spent more time outside as compared to the respondents aged >35. Surprisingly, both age groups prefer sleeping and respondents aged <35 prefer cleaning compared to respondents aged >35 years of age.

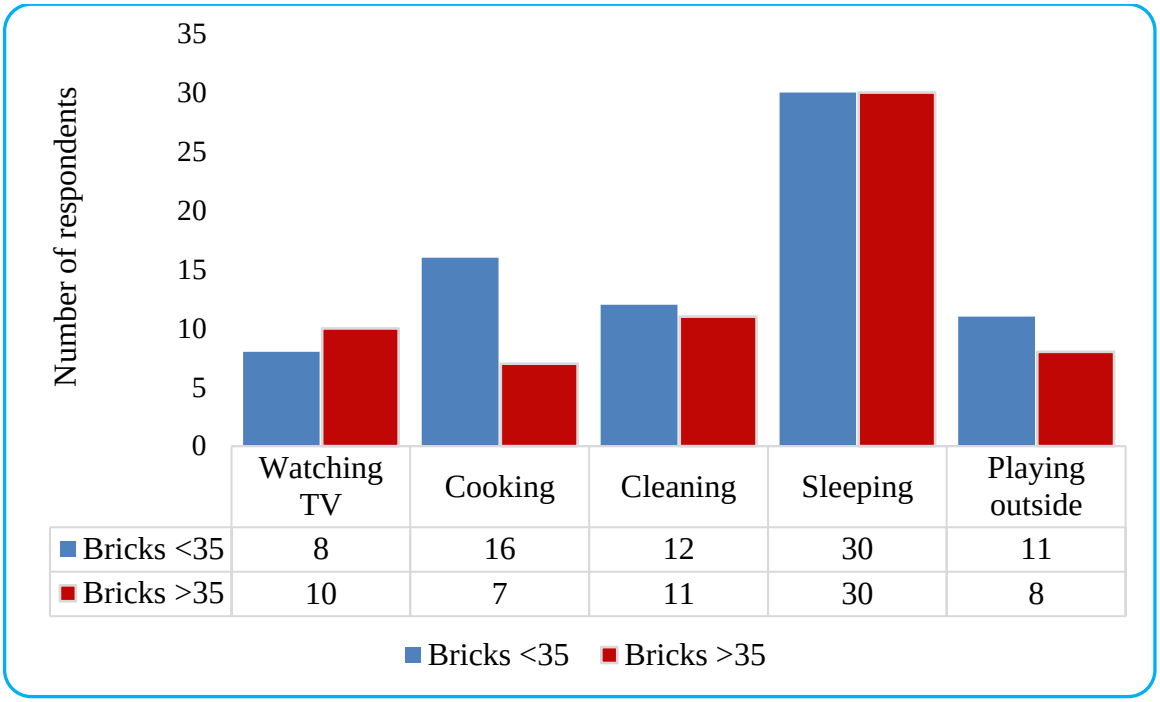


Figure 7: Age and activity patterns of respondents in the brick type house

Table 10 shows the results of time activity pattern as influenced by age for the brick type buildings are shown. Based on this finding it can be observed that age does not play a key role in determining variability on time-activity pattern.

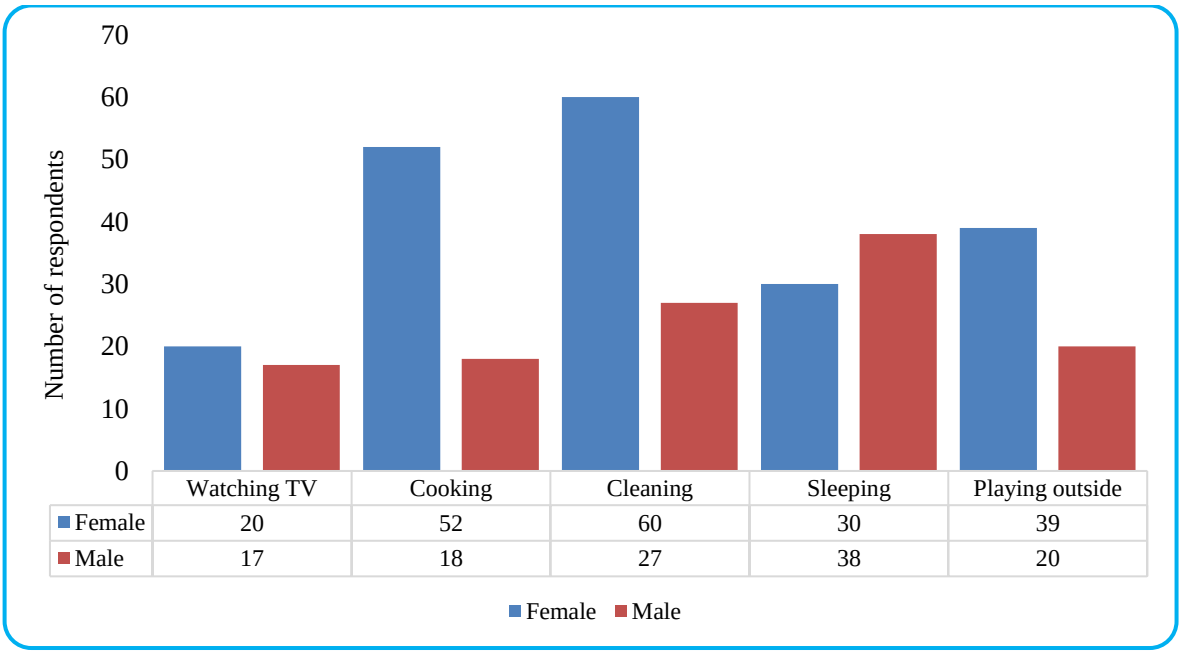
Table 10: Time activity patterns of people >/< 35 in brick houses

Activities	<35 years		>35 years	
	N	Time spent	N	Time spent
Watching TV	8	2 hours	10	3 hours
Cooking	16	30 minutes	7	45 minutes
Cleaning	12	1-hour 30min	11	45 minutes
Sleeping	30	7 hours	30	7 hours
Playing outside	11	3 hours	8	30 minutes

3.11 GENDER AND ACTIVITY

3.11.1 Gender and activity of the respondents living in the shacks

In terms gender and activity, Figure 8 indicates that more females in shack households spent time cleaning and cooking as compared to males. The majority of female spend time cleaning and cooking as compared to males in shack households. Based on Figure 8, an equal number of males and females spend time watching television (TV).



	Watching TV	Cooking	Cleaning	Sleeping	Playing outside
Female	20	52	60	30	39
Male	17	18	27	38	20

Figure 8: Activity patterns by gender and shack households

3.11.2 Gender and activity of respondents living in the brick type houses

Figure 9 illustrate the activity patterns by gender in brick households. The majority of the females spent their time cooking and cleaning. Meanwhile male and female respondents spent same amount of time watching TV.

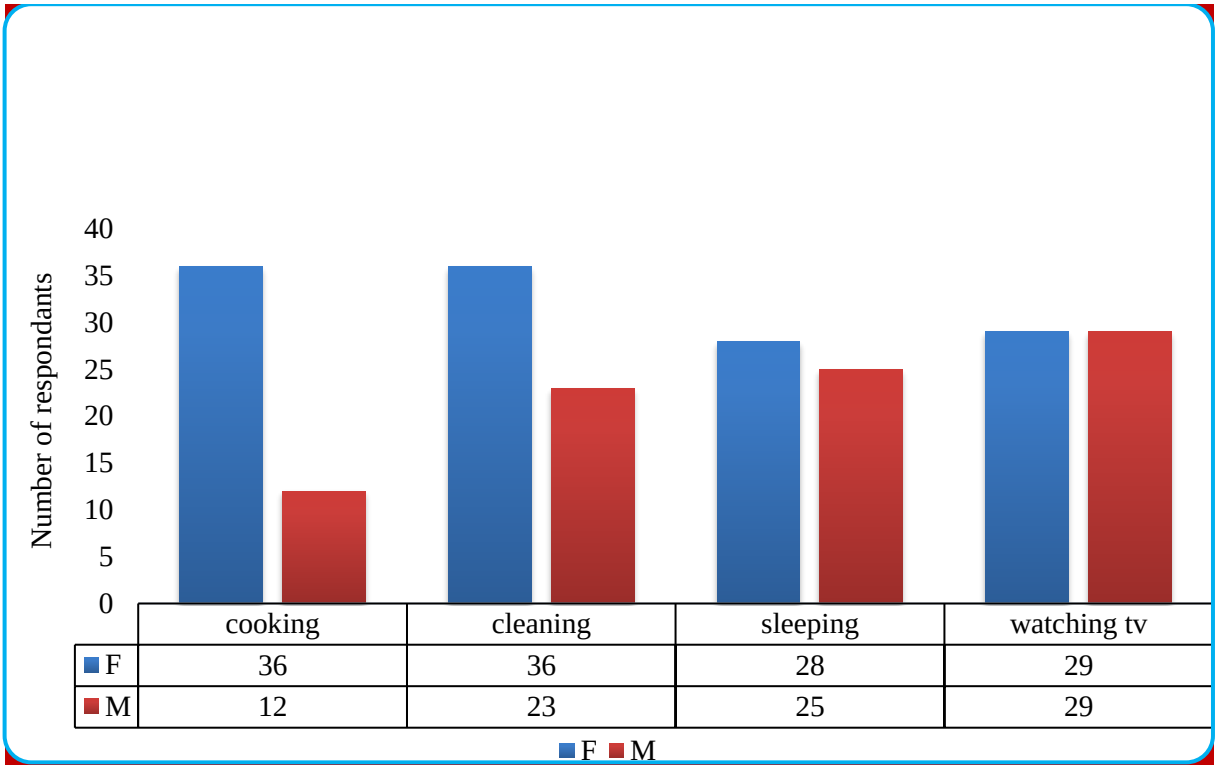


Figure 9: Activity patterns by sex in brick households.

3.12: Diaries

In this study, diaries were used for collecting data. Figure 10 shows the total time spent in neighborhood and out of the neighborhood. Based on Figure 10, it can be observed that most of the time was spent at home (43.6%) and school (26.6%). About .8% of the respondents spend time indoors with windows open.

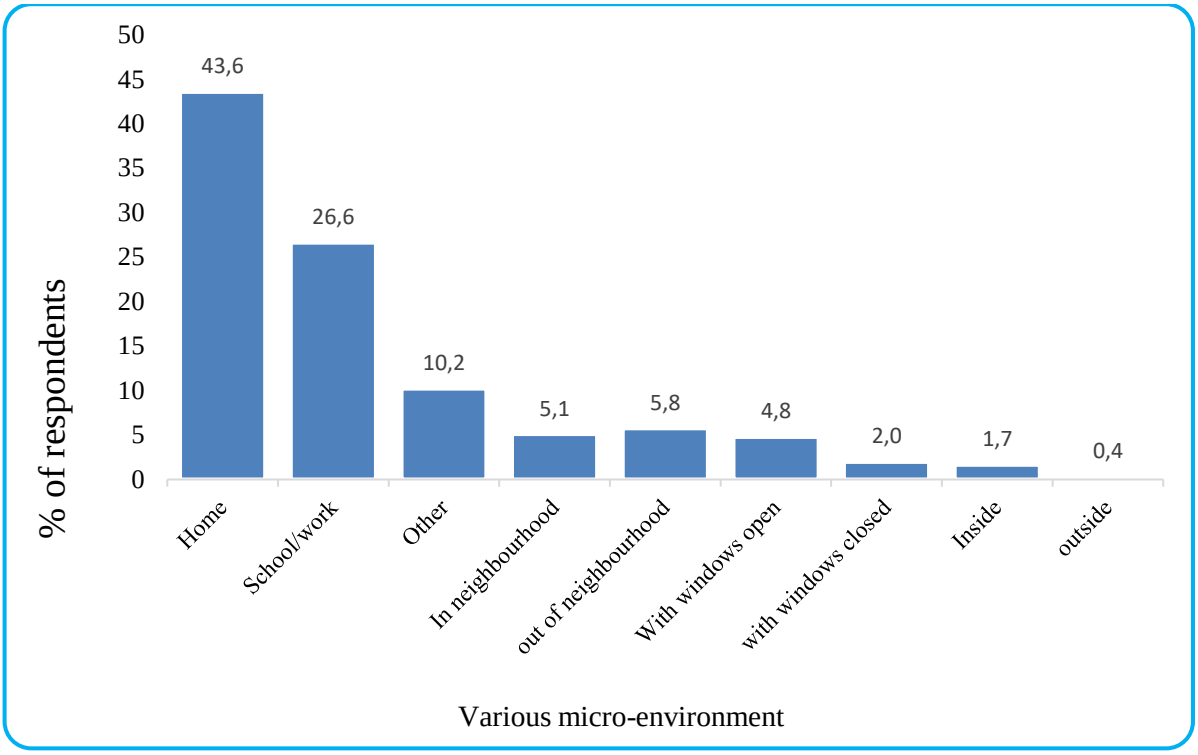


Figure 10: Percentage indoor macroenvironment

Figure 11 illustrates that more respondents spent more time at home in microenvironments. Respondents spent more time outdoor at home (43.6%) in the microenvironment and the least spend time inside the microenvironment (17%).

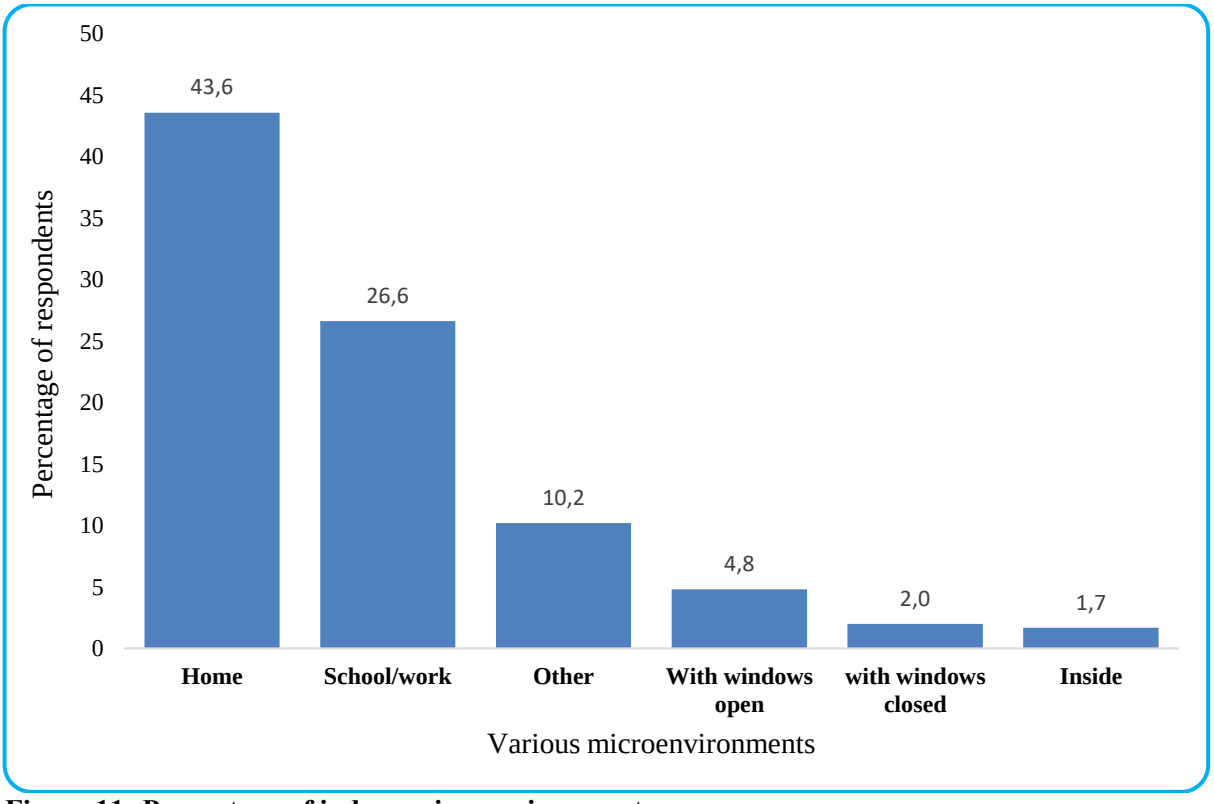


Figure 11: Percentage of indoor microenvironment

Figure 11 shows that more respondents spent time outdoors out of neighborhood, followed by outdoor microenvironment in neighborhood. Based on the result it can be noted that there is a small percentage (3.3%) of respondent who spent time outside church on weekends.

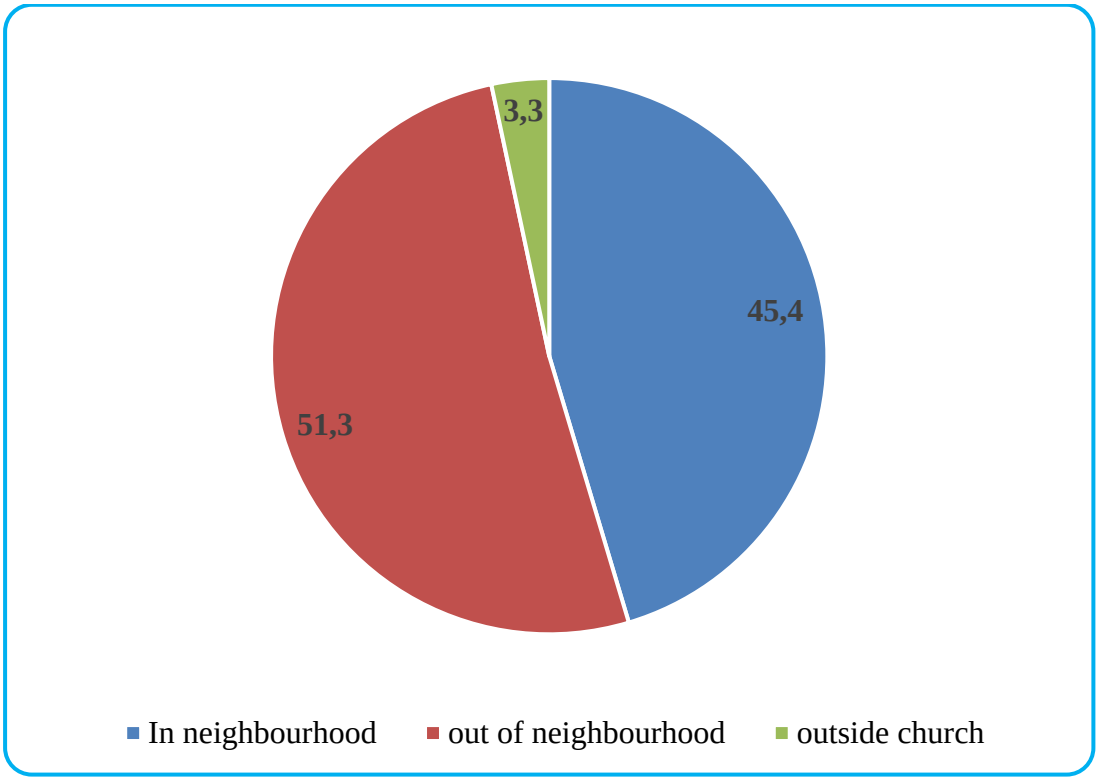


Figure 112: Percentage of outdoor environment in neighborhood

CHAPTER 4: DISCUSSION

This chapter discusses the results of the study in relation to existing literature. It highlights discussion on the time-activity patterns of the community of Matholesville. Time-activity patterns give key information on population exposure modeling. Lastly, the chapter provides the limitations and also gives information on the strengths of the study are explained.

4.1 DISCUSSION

This study aimed describing variations on time-activity patterns based on age, sex, and socioeconomic status amongst residents of low-income communities in South African township (Matholesville informal settlement). Analyses of the results include examination of variables such as age, race, education, gender, race, employment status and season. Studies of personal exposure have found that human activity patterns are critical in identifying and determining human exposure to environmental pollutants (66).

4.2 DEMOGRAPHIC PROFILE OF RESPONDENTS

In this study, it was observed that there were more females (68% living in shack household), who participated in the study. It was further found that most of the respondents living in the brick type were females (60%). This suggested that females as the only adults in their household, they are expected to be responsible for supporting their households economically.

Based on the results in Table 1, it was found that there are more females aged 18-35 (i.e., youth as defined in the South African policy) living in the shacks compared to brick households. This is expected as there is more youth migrating from villages to cities to seek better opportunities in the urban areas. This places emphasis that rural areas continue to feed migrants into settlements in urban areas. Due to high rental in cities, this income group find themselves staying in informal settlements. According to the results in Table 1, there are more unemployed respondents (63%) in shacks and 53% in bricks households. Unemployment rate is high in informal settlement. It is noteworthy that the unemployment rate in South Africa, accounting for approximately 35.3% (78). As result of limited employment opportunities, the most popular informal sector occupations in informal settlements among women household heads are spaza shops, shebeens and street hawking consequently, the results are expected in an informal settlement where people can build their own housing structures using cheaper materials such as corrugated iron. This result in informal settlement dwellers being exposed to insecurities, hardships, and hazards from

living in overcrowded conditions on neglected and sometimes unsuitable land. Lack of decent job opportunities for them is manifested as most people staying in informal settlement are street vendors (16). A study by (54) found that, people who live in informal settlements are often excluded from opportunities, decent working environments, security, capacity, and empowerment that would assist them to gain better control over their lives and health. Those that are unemployed spend time indoor in the microenvironment at home and more time outdoor elsewhere. Therefore socioeconomical factors such as employment has proven to have an influence on time activity pattern

In terms race categorization, majority (75%) are blacks followed by colored and Indians living in this kind of informal settlement. The results of the study were not surprising, in terms of race living in the informal settlement. This were supported by study by Larson, Green and Cordell, (2011), that showed that around 4.3 million adults, mostly black, live in this kind of informal setting. This means that parents are unemployed and unable to support their children's daily needs and children financially to pursue their studies. The lack of financial support due to parents' financial income, this impact on both their daily needs and education, result in children dropping out of school or not furthering their studies. It is important to note that who are from a social economically disadvantaged families are more likely to drop out of school as compared to those from well-off families.

Figure 2 presented information about the income of the respondents living in the informal settlements. The result showed that the average household income was R4 304 for those employed and living in brick type compared to those living in shacks. Those living in shacks are supported by their lowest income. The implications are that they earn less money to maintain and sustain themselves to live in a standard way (40). For those who are employed, they are either employed as security guards, domestic workers or cleaners (45).

4.3 TIME SPENT COMMUTING TO WORK

An important result of the analysis of the study is that respondents in this informal settlement reside within 2.6 kilometers (2600 meters) radius of Roodepoort central building district (CBD). Based on the results in Figure 3 showed that the main mode of commuting to work is walking followed by public and private transportation. This was an expected results because most of the people living in the informal sector walk or use public transport, to commute work on daily basis. The results showed that there was no noticeable difference in the average time taken to commute to work on daily basis. In terms sex and time spent

commuting to work an assumption was made that either for women or men, who access public transport such as taxi spent almost the same time. Concerning walking to work a 30-minute walk was found for both sexes from their dwellings. In the context of the informal settlement, women were likely to walk than men, while men tended to use private transport.

4.4 SOURCE OF ENERGY

The main source of energy in this informal community is kerosene (Figure 2). One possible contributor to the use of kerosene as a source energy can related its cost-effectiveness and ease of accessibility. Residents living in the informal settlements are also known to use wood as a source of energy. The result of the study found that coal was primarily used for cooking, heating up the microenvironment (indoor and outdoor) and water heating while kerosene was mostly used for lighting and cooking. These findings were supported by Makonese et al. (80), who found that coal was used for cooking, water heating and heating up the rooms. However, studies have shown that coal burning for domestic purposes is associated noxious emission which end up in the atmosphere causing global warming Makonese et al. (80). This can also result in individuals living in the informal settlements being exposed to contaminants released during coal burning than others. From the findings of this study, fewer households used LP gas for in their households; the fuel is regarded as unsafe for use in these types of settlements. Factors such as the season, the availability and price of fuels, and socio-economic factors are a major hindrance to the use certain sources of energy. Messages that promote the use of cleaner sources of energy may be more important to reduce the burning for domestic purposes.

4.6 TIME-ACTIVITY PATTERN

Research has shown that time activity pattern is critical in estimating exposure to environmental contaminants. People that live at the same location and in different house types, this study did, have differences in activity pattern and their corresponding time in the micro-environment. The findings of this study showed that there was a difference between people living in the shack and brick type houses among this population living in this informal settlement. People in the shacks spent more time outdoor compared to those brick type. Shack house are associated with discomforts during hot days compared to brick type houses Given the limited spaces in the shacks, it more likely that the residents would spend more time outdoors. The results of the study were comparable to Arson et al. (79) found that the most impoverished of the population living in the shacks have the greatest number of people

per household, which support the findings of this study that people living in the shacks prefer outdoors. The study findings indicate that the time activity pattern differ between residents living in shacks and those living in brick type houses and highlight the need to carry out research to understand exposure in these house types.

The current study showed that the respondents performed activities such as watching TV, cooking cleaning, sleeping, and playing outside (Table 5). Based on activities performed by respondents living in shacks and brick type houses, time spent on sleeping and watching TV were the highest compared to those living in the shacks. The results further showed that for other activities such as playing outside, and cleaning was almost similar. If time spent on performed activity indoors is closely linked to the type of house among the respondents, time spent indoors may be an important consideration for interventions that seek to understand exposure indoors.

4.7 TIME ACTIVITY PATTERN AMONGST DIFFERENT AGE GROUPS

Age is known to be associated with time activity patterns within in a residential setting. This study extends from previous studies which have shown that age is important in understanding time-activity patterns amongst different age groups. Results show that on average <35 spent, on average, the less time per day sleeping. In all age groups women tend to spend less time sleeping than men, but the difference is relatively small (30%). The next most common activity for all the age groups was cooking. This accounted for as many as 75 minutes, on average, of an elderly man's day. Women aged <35 spent the more cooking, almost one hour per day. The other common activities are cleaning.

The results on time spend on indoor activities are shown in Table 5. Based on the time spend in indoor activities it is surprising that respondents in both shacks and brick type household spend similar hours sleeping followed by watching TV, cleaning, and cooking. One the explanation for the scenario is that majority of them are unemployed and not schooling. Women living with no adults also spent less time on social and cultural activities than men and those living with other adults. Older women aged >35 who are the only adult in their households spent more time per day on performing household chores, on average, than their peers living with other adults on household chores. However, there is no difference in the average time spent per day on this activity between younger women aged<35 who live with adults and those who live without other adults. Men of all ages (</>35) living with other adults spent the less time per day, on average, on household chores.

4.8 TIME ACTIVITY PATTERN FOR DIFFERENT SEX

(Fan, Wu and Ohman-Strickland, (2010a) suggested that adults spent most of their time at home and largely indoors. There was a significant different between Females and Males on how they spend their time indoor. Females spend more time indoors at home compared to the male counterparts. Although other studies indicate gender differences in time spent in other indoor and outdoor locations (5), the findings of the study did not reveal any such differences. Cultural aspects affects the fuel choices and the quantity consumed (81).

The participants are found to spend more of their time indoors during weekend days and workdays, respectively. Data on time spent in microenvironments plays a critical role on individuals' exposure assessment. In addition, it was estimated that participants approximately 4.8% and 2.0% of their time in transportation during weekend days and workdays, respectively. Therefore, they spent less time outdoors in microenvironments during workdays than weekend days because they are at work and school. Males' activity time pattern significantly differed from that of woman during weekends. However, but both genders had similar activity patterns during workdays. Men spent little time indoors than their women' counterparts, and more time outdoors than females. The activity pattern found in this study (27) is slightly different than that for North Americans and Europeans, who spend more time indoors and in transit, as shown in the discussion of the previous section. It is also very different than that observed for Koreans (5), who spent about 59% and 67% indoors on workdays and weekends, respectively.

4.9 EFFECTS OF SOCIOECONOMIC STATUS ON TIME ACTIVITY PATTERN

Most of the respondents living in the brick houses have attained secondary education level (83%); compared to the respondents living in the shack houses. One other reason for this situation is that parents are unemployed and unable to support their children's daily needs and children financially to pursue their studies. The lack of financial support due to parents' financial income, this impact on both their daily needs and education, result in children dropping out of school or not furthering their studies. It is important to note that who are from a social economically disadvantaged families are more likely to drop out of school as compared to those from well-off families. This is associated with lack of access to proper hygiene facilities and inability to afford school uniform, exercise books and textbooks. However, there is limited research to understand the dynamics of how informal settlement way of living influence their access opportunities to improve their social and economic status

in life. Based on these results it is important for the government to strengthen policies to assist in closing the gap in terms of educational attainment between those who live in the informal settlement and middle- and high-income groups.

It was observed that most participants from the informal housing structures were not using electricity due to lack of connection to the electricity grid during the survey, except for a few which were connected illegally or using petrol-powered electric generators.

Informal settlements are the least served by public transportation. Streets are predominantly unpaved and narrowed and dependence on walking is very high since Matholesville is closer to town. Because of the unplanned setup of these areas there has been road infrastructure development that is very poorly constructed, with narrow, roads that are unpaved constituting the road infrastructure. This nature of the setup has limited the opportunities for regular public transport minibuses providing transportation for most of the urban poor who live in these informal settlements.

4.10 DIARIES

Time/activity diaries are found to be having an understanding in human activity patterns (20); Epidemiological studies and exposure assessment, including time/activity diaries are used to identify the use of microenvironmental settings (82); in addition, to gather qualitative and quantitative data on the activities that contribute to personal exposure and such as duration of cooking activities and smoking habits (83). Furthermore, information collected using the diaries is found to be accurate, in particular concerning gender division activities. (84).

The findings from the diaries showed that most of the respondents living in the shacks are unemployed (63%), compared to the respondents in the brick household (53%). The parents socio-economic status in the study was based on the family income, type of employment parents do and their community social status(85). It is believed that low socioeconomic status have a significant negative impact on academic achievement. Therefore, the communities have limited access to important resources; as a result, it creates more stress at home (54).

On many factors contributing to for the time spent in different microenvironments, the study revealed that status of employment and gender were the main contributors to the time spent in various microenvironmental settings. work status and gender to be the main influencers

of time spent in different microenvironments (86). However, temperature played a significant role in driving the time individual time spent pattern in the microenvironment (15); it should be noted that Johannesburg as the area of study experience extreme cold weather especially during winter season, as a results it may influence the time spend indoors. However, several studies conducted revealed that variables such as educational level, season, gender, family type and lastly precipitation have no influence to the amount of time individuals spent in the environmental setting. However, considering the limitation of number of studies done focusing on time activity, the study revealed that the time spent by population in the microenvironment setting differs significantly [for the home indoor (43,6%), outdoor at home (51.3%), and on transportation activities (23-51%)] compared to internationally generated data). when taking into account the limited number of studies considered in this evaluation (68); (87). There are several factor that contribute to the finding of studies done to determine the time spent on the different microenvironment which include, instrument used for data collection , sample size, data analysis, participants socio economic status and demographic profile (55). However, the respondents in the shack type household preferred spending majority of their time indoor during winter period (11 hours), this could be the results of the shacks being small and too cold in winter. Similarly, in the brick type household the respondents spend majority of their time indoor during winter season (11 hours). Bricks households have warmer conditions in winter, they have electricity. However, the study conducted by (13) revealed that the respondents spend most of their time outdoor during winter season (1h 19mins), compared to indoor during summer season (1h 11mins). A longitudinal study conducted in California, revealed that kids prefer to spent most of their time indoor learning during the day(16).

Majority of the activities of the participants differ significantly based on the day of the week (Monday to Friday); even during the weekends (Saturday and Sunday) there is a significant difference on the time pattern activity between working and studying participants. Studies done in developing countries on time pattern activity specify a day which households or people preferred to be interviewed to gather required information on the distribution across the week days. However, in South Africa such studies have not done due several factors, including logistics challenges such as contacting respondents. However, field workers were requested to give support by assisting with community data collection in different days of the week; between Tuesday and Friday. The strategic plans used was supported by other studies that provided evidence from data collected using time pattern activity; which

revealed that weekly data on time activity pattern was likely to be the same regarding the type of activity that was conducted. However, there is a variation on time activity pattern during week days (Monday to Friday).

4.11 LIMITATIONS OF THE RESEARCH STUDY

The study limitation includes that the study data analysis was focused on two microenvironments settings; the setting included transport and indoor residence compared with studies done somewhere that focused on microenvironment settings. The study only focuses on Matholesville informal settlement. Therefore, there is need for future research focus on and large sample size and the need to involve more stakeholders as participants, to ensure the study forms a basis of adjudging how variations on time-activity patterns based on age, sex, and socioeconomic status amongst residents of low-income communities in South African township (Matholesville informal settlement).

CHAPTER 5: SUMMARY AND CONCLUSION

This chapter gives summary of the main findings of the study and conclusions reached thereof. Even though the results achieving the study aim, knowledge gaps were identified, the study is giving rise and a need for possible research ventures which are highlighted in this chapter.

5.1 SUMMARY

The most important and main outcomes of this study can be used in human exposure surveys. Individual exposure to environmental substances is mostly determined by time-activity patterns in the microenvironment while moving across different points or microenvironments. Given their routine and daily work, adults that are employed spent most of their time at work and in transit and spend less time in the neighborhood on weekdays than the school children and adults that are not employed as per the results on the diaries. Time-location patterns on weekends tend to be similar among these three types of subjects. Moreover over half of the school going children and adults that are unemployed reported spending no time in transit. The adults that are unemployed and school children spent more time indoors in microenvironments in winter and more time outdoors in microenvironments in summer, which is the basic trend that has been observed in other human activity studies (2), females spent significantly most of their time indoors at home compared to their male counterparts. Although other studies indicate gender differences in time spent in other indoor and outdoor locations, our data did not project any of the differences (55).

The study reveal that the time activity pattern varies, most of the time is spent at home amongst different age groups in Matholesville informal settlement, a low-income community in Johannesburg township, South Africa. The conclusions and recommendation reached in this research study concerning the variations on time-activity patterns based on age, sex, and socioeconomic status amongst residents of low-income communities in South African township (Matholesville informal settlement).

5.2 FUTURE RESEARCH AVENUES AND RECOMMENDATIONS

This study provided the basis for exposure assessment in South Africa and in informal settlements. It is also expected that the other researchers looking into expanding this topic,

increase the number of variables and increase the study sample, as this study had only 130 participants in the Matholesville informal settlement, South Africa.

- ✓ The future studies may be carried out covering a larger population density to gain more detailed time activity pattern.

- ✓ This study focused on a low-income settlement which have different characteristics to semi-formal, rural, high tax yield settlements in South Africa. Therefore, a larger study focusing on different socio-economic class need to be carried out to have a complete time activity pattern data for South African population.

- ✓ The current project focused only on adult age group without considering vulnerable groups time activity pattern. An additional study focusing on children time activity pattern is required to gain an understanding on what activities children spend the most time at.

5.3 CONCLUSION AND SIGNIFICANCE

Results from diaries showed that the respondents spent most of the time indoors (88.9%), of which most was spent indoors at home, with limited time spent outdoors (5.8%) or in transit (5.3%). Age, gender, season, and rurality were important predictors of time activity patterns global statistics (32)**.** In the absence of the South African data base, we are forced to use the USEPA data base, the South African sub population is different from the American sub population, hence we found this study is important as it brings about providing information closer to the sub population, we are estimating the risk on because time was considered as an important variable because of exposure construction.

For the first time this study attempted to calculate activity and time spent pattern in the South African sub population resembling a low-income community. The study findings are in agreement with the general norm that suggest that people spend about 80% of their time indoors. However, the time spend indoor and outdoor will depend on different sub population, since this study was only limited to informal settlement In this study it is suggested that people in the informal settlement where they have lack of resources to keep their activities on going when they are in the microenvironment, they are forced to lookout for entertainment activities and other services outdoor, leading to their time spent being increased or mainly dominated by outdoor events. Therefore, in order to quantify what people are likely to be exposed, time becomes an important variable that can be used for better estimation for external exposure.

This study was done on a small population, a broader study to be conducted in various south african sub population including high income, middle income, and low income. Although other studies indicate gender differences in time spent in other indoor and outdoor locations, our data did not reveal any such differences (55)

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ANNEXURE 1: QUESTIONNAIRE.

Form unique no: _____

SECTION 1: DEMOGRAPHIC DATA

Location _____

Age: _____

Highest grade passed: _____--

Marital status_____

Race: colored ☐ Black ☐ White ☐ Indian ☐

Sex: Female ☐ Male ☐

Employment status: Employed ☐ Unemployed ☐

Household income_____

Family size_____

Nationality_____

SECTION 2: TECHNICAL QUESTIONS

Type of housing: Bricks ☐ shack ☐ dwelling ☐

Are you living with a smoker? Yes ☐ No ☐

What activities do you do when you are home? Watching TV

Cooking

Cleaning

Sleeping

Playing outside

Other – specify?

How much time do you spend on these activities?_____

Do you prefer to spend time indoor ☐ outdoor ☐

Most preferred season to do your activity. Summer ☐ winter ☐ Autumn ☐ Spring

☐

Do you have chemical in the house e.g. (alcohol, cleaning chemicals, cooking chemicals, body detergents)? Yes ☐ No ☐

How do you store them?_____

How do you travel to work/school? Private transport ☐ Public transport ☐ Walk

☐

☐

Time spend on traveling_____

What source of energy are you using for cooking? Electricity ☐ Wood ☐ Gas ☐ other (fuels) – specify _____

ANNEXURE 2: DIARY

Activity log									
	Indoors			Outdoor		In vehicle		In church	
Time (hours)	Home	School or work	Other	In neighborhood	Out of neighborhood	With open windows	With closed windows	Inside neighborhood	Outside neighborhood
8 am									
9 am									
10 am									
11 am									
12 pm									
1 pm									
2 pm									
3 pm									
4 pm									
5 pm									
6 pm									
7 pm									
8 pm									
9 pm									
10 pm									
11 pm									
12 pm									
1 am									
2 am									
3 am									
4 am									
5 am									
6 am									
7 am									
8 am									
9 am next day									
10 am next day									

11 am next day									
12 pm next day									
1 pm next day									

School work

Out of neighborhood

In neighborhood

With open windows

With closed windows

ANNEXURE 3: ETHICAL CLEARENCE

UNIVERSITY OF THE WITWATERSRAND, JOHANNESBURG

HUMAN RESEARCH ETHICS COMMITTEE (MEDICAL)

Office of the Deputy Vice-Chancellor (Research and Innovation)

TO: Ms HPB Bhuda
School of Public Health
Division of Occupational Health
medical School
University

E-mail: serapedi.bp@gmail.com

CC: Supervisor: Drs D Masekameni and D Mmereki
<Daniel.Masekameni@wits.ac.za>
and <HREC-Medical Research Office@wits.ac.za>

FROM: Mr Iain Burns
Human Research Ethics Committee (Medical)
Tel: 011 717 1252

E-mail: Iain.Burns@wits.ac.za

DATE: 2021/07/02

REF: R14/49

PROTOCOL NO: **M210209** (This is your ethics application reference number. Please quote it in all enquiries, oral or written, relating to this study.)

PROJECT TITLE: *Activity and time spend patterns of residents in a low-income settlement in the City of Johannesburg, South Africa*

Please find attached the Clearance Certificate for the above project. I hope it goes well and that an article in a recognized publication comes out of it. This will reflect well on your professional standing and contribute to Government funding of the University.

MSWorks2000/Iain0007/Clearscan.wps

UNIVERSITY OF THE WITWATERSRAND, JOHANNESBURG

R49 Ms HPB Bhuda

HUMAN RESEARCH ETHICS COMMITTEE (MEDICAL)
CLEARANCE CERTIFICATE NO. M210209

NAME: (Principal Investigator) Ms HPB Bhuda

DEPARTMENT: School of Public Health
Division of Occupational Health
medical School
University

PROJECT TITLE: *Activity and time spend patterns of residents in a low-income settlement in the City of Johannesburg, South Africa*

DATE CONSIDERED: 2021/02/26

DECISION: Approved unconditionally

CONDITIONS:

SUPERVISOR: Drs D Masekameni and D Mmereki

APPROVED BY: Dr CB Penny, Chairperson, HREC (Medical)

DATE OF APPROVAL: 2021/07/02

This Clearance Certificate is valid for 5 years from the date of approval. An extension may be applied for.

DECLARATION OF INVESTIGATORS

To be completed in duplicate and **ONE COPY** returned to the Research Office secretariat on the 3rd floor, Phillip Tobias Building, Parktown, University of the Witwatersrand, Johannesburg.

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 submit details to the Committee. **I agree to submit a yearly progress report**. When a funder requires annual re-certification, the application date will be one year after the date when the study was initially reviewed. In this case, the study was initially reviewed in **February** and therefore reports and re-certification will be due in the month of **February** each year. Unreported changes to the study may invalidate the clearance given by the HREC (Medical).

Signature of Principal Investigator

2021-08-20
Date

ANNEXURE 4: PERMISSION LETTER

CITY OF JOHANNESBURG
METROPOLITAN MUNICIPALITY

COUNCILLOR

21/04/ 2021

Region C Ward 127

Letter of approval to conduct study in ward 127

Dear Sir/Madam

This letter serves to confirm the approval for Mr/s Hope Prudence Boipelo Bhuda from the University of the Witwatersrand to conduct a study in 127 (Matholesville)

I wish her well in this regard.

Yours in community service,

Councillor Sabelo Nscana
Ward 127
082 818 1170

P.P Sabelo Nkosi