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The Factors Influencing the Behavioural Intention of Overweight Adults to use Wearable Devices for Sustained Health Monitoring

by

Oluwaseyi Caleb Ogundele

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Abstract

The volume of wearable devices that can be used for sustained health monitoring purposes is continuously growing within the healthcare sector. These devices allow users to track their own activity levels in real time. However, there are factors that may inhibit the behavioural intention to sustain the use of wearable devices for health monitoring in the long term by overweight adults. These factors include privacy concerns, costs of obtaining wearable devices, theft, frequent charging and short battery life of wearable devices and bulkiness of some wearable devices. It is against this backdrop that this study examined **the factors influencing the behavioural intention of overweight adults in South Africa to make use of wearable devices for sustained health monitoring.** This research made use of the Expectation Confirmation Model (ECM) as the theoretical foundation of the study.

In achieving the aim of this study, a qualitative research approach was used. The purposive sampling technique was selected to identify twenty (20) overweight adults (aged 18-59 years) who are using wearable devices in East London, South Africa. Interviews were conducted with the twenty participants to identify the factors that will influence their behavioural intention to make use of wearable devices to monitor their health. Through thematic analysis, data provided by participants was grouped and summarised into relevant themes to answer the main research question.

The study developed a framework that identifies the factors influencing behavioural intention of overweight adults to continue using wearable devices for sustained health monitoring. The factors that were identified include confirmation, perceived usefulness and satisfaction of wearable devices for sustained health monitoring. The realisation of weight loss, monitoring of daily activities and calories through the use of wearable devices was found to positively influence the behavioural intention of the users of wearable devices to continue their usage. However, the major factors that may inhibit the continuous usage of wearable devices for sustained health monitoring are privacy concerns, costs of obtaining wearable devices, theft, frequent charging and short battery life of wearable devices and bulkiness of some wearable devices.

Based on the findings, the study recommended the following: (1) the wearable device manufacturers should assure the users of their privacy and confidentiality by providing the needed interfaces for this purpose; (2) the manufacturers of wearable devices should make the devices less bulky so that they can be more portable; (3) South African government should provide security operatives in isolated areas where people are not feeling secure; (4) the manufacturers of wearable devices make the purchase prices of wearable devices more affordable, especially for low income people; and (5) the manufacturers of wearable devices should improve on battery life and quality of wearable devices so that the devices are more time efficient and require less charging of the devices.

Keywords: Behavioural intention; overweight adults; wearable devices; Expectation-Confirmation Model.

Declaration

I, Oluwaseyi Caleb Ogundele, Student number 201608332, hereby declare that:

- I am fully aware of the University of Fort Hare's policy on plagiarism and I have taken every precaution to comply with the regulations.
- The work in this dissertation is my own work.
- All sources used or referred to have been documented and recognised.
- This dissertation has not previously been submitted in full or partial fulfilment of requirements for an equivalent or higher qualification at any other recognised institution.

Ethical clearance certificate number ISA051SOGU01 (Refer to appendix A)

21 December 2018

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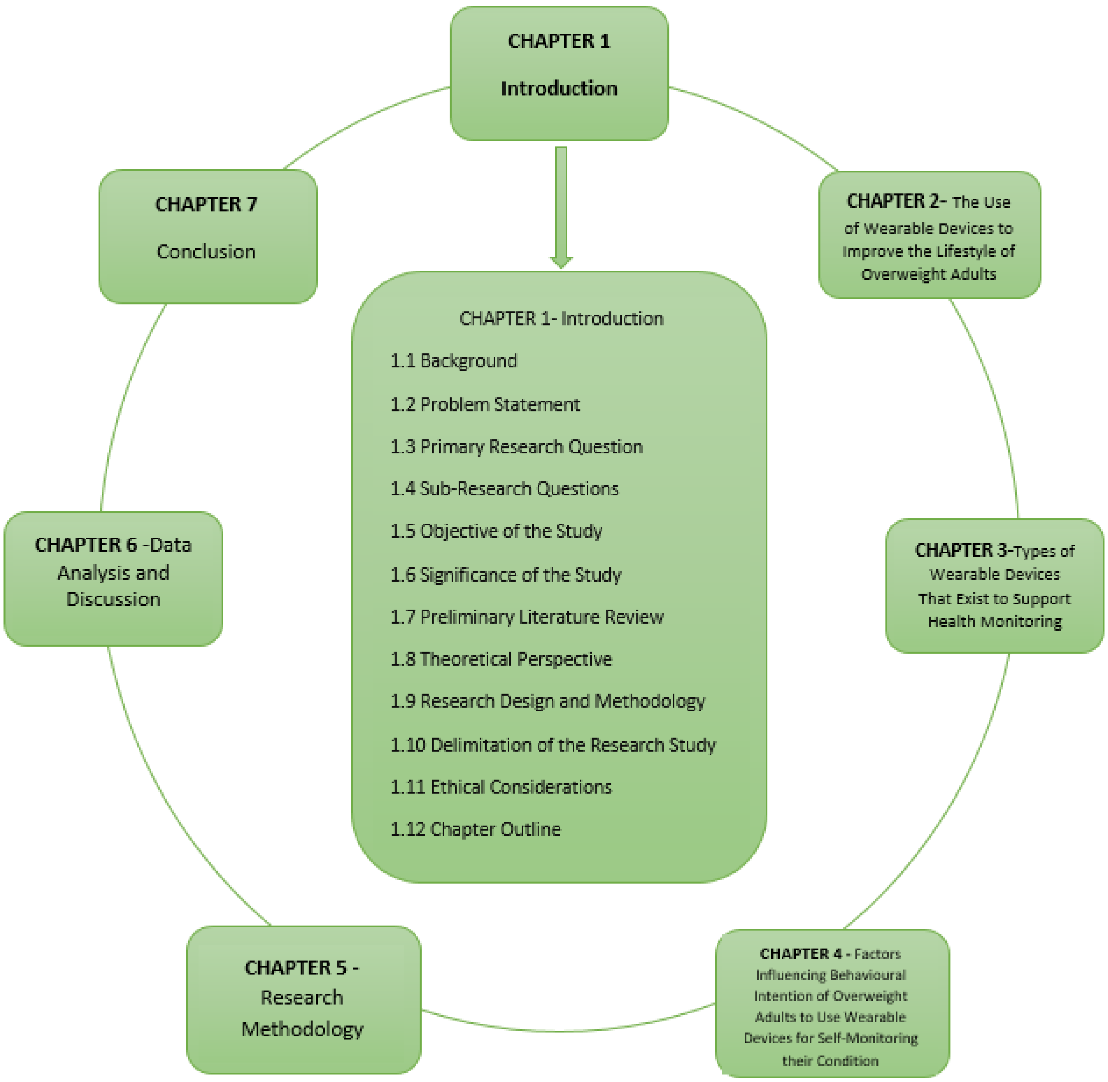
Acronyms

BMI	Body Mass Index
CGM	Continuous Glucose Monitor
DIY	Do It Yourself
eHealth	Electronic Health
ECG	Electrocardiography
ECM	Expectation Confirmation Model
ECT	Expectation Confirmation Theory
EHRs	Electronic Health Records
EMG	Electromyography
HITSs	Health Information Technology Systems
ICTs	Information and Communication Technologies
IS	Information Systems
LED	Light Emitting Diodes
mHealth	Mobile Health
NDoH	National Department of Health South Africa
PPG	Photoplethysmography
PWC	PricewaterhouseCoopers
TAM	Technology Acceptance Model
WHO	World Health Organisation

CHAPTER 1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Introduction

1.1 Background

The prevalence of overweight people has doubled over the last three to four decades (Seidell, & Halberstadt, 2015; Omran, 2017). Approximately 1.9 billion adults older than 18 years of age are considered overweight, which affects both their lifestyle and health (World Health Organisation [WHO], 2016). Statistics show that the overweight prevalence figures have increased in Africa as well, with over 70% of women and 23.3% of men being considered obese in South Africa (The Heart and Stroke Foundation, 2016).

Being overweight is a condition that is characterised by a person having excess accumulated body fat (Nichols, 2016). According to the National Department of Health South Africa [NDoH] (2015: p.21), "Overweight and obesity reflects a gain of excess body fat, resulting from the cumulative and initially unnoticeable effects of day-to-day eating and physical activity behaviours that create a surplus of energy consumed relative to expended". Being overweight has been found to increase the risk of developing joint disease, stroke, type 2 diabetes, heart diseases, hypertension, depression, and in some cases, cancers (NDoH, 2016).

Self-monitoring has been identified as a key determinant in the management of excessive weight gain (Perenc, Radochonska, & Zaborniak-Sobczak, 2015). The aim of health monitoring is to help patients take responsibility for their health as well as to attain a healthier weight. Sustained monitoring involves an increased knowledge about diet and activity levels for effective decision-making related to weight control. Findings from previous studies have suggested that sustained self-monitoring is a vital element of treating overweight adults. (Asch, Muller, & Volpp, 2012; Perenc *et al.*, 2015). To this end, Gouveia, Karapanos, and Hassenzahl (2015) proposed a framework for healthcare which emphasises self-monitoring of activity levels combined with advancement in technology. Subsequently, the development of wearable health monitoring devices has advanced since then. According to Gandhi, and Wang (2014), technological innovations have supported the advancement of different wearable devices and sensors for self-monitoring which include smart shoes, clothing, watches and activity trackers.

Wearable medical devices are an effective way to ensure preventative health monitoring of weight at an initial stage in order to improve patients' activity levels (Zheng *et al.*, 2013). According to Kaewkannate, and Kim (2016), "a wearable device is a new type of technology in the form of small hardware that includes an application with tracking and monitoring fitness metrics such as distance walked or run, calories consumed, and in some devices heart rate and sleep tracking" (p. 1). Wearable devices have a positive impact on overweight adults' health and wellness, offering a possible solution to improving their activity levels (Kelley, 2014). The WHO strongly endorses physical activities and monitoring devices to support the overweight adults' lifestyle and subsequently, these devices have received growing attention in the human-computer interface community (Randriambelonoro, Geissbuhler, Chen, & Pu, 2015). Wearable devices allow self-monitoring of patients' behaviour on a daily basis from which decisions about their health are usually made to enhance their lifestyle (Asch *et al.*, 2012). According to PricewaterhouseCoopers (2014), overweight users of wearable devices may not be ready to disclose daily results to their friends and family, but might be eager to disclose the weigh-ins with fellow overweight adults. Also, to improve patients' engagement in self-tracking of their lifestyles, researchers have capitalised on the use of different behavioural interventions such as mobile apps, SMS notifications and wearable devices to increase activity levels (Van Camp, & Hayes, 2012; Kurti, & Dallery, 2014).

However, although the use of wearable devices is capable of promoting an active lifestyle and effective weight management for overweight adults, consistent utilisation of activity trackers remains a daunting issue (Chen, Chen, Randriambelonoro, Geissbuhler, & Pu, 2016). Thus, wearable devices may have less impact on a patient's lifestyle without a consistent action plan and commitment to self-monitoring. Ledger's (2014) study shows that most patients stopped using activity trackers after six months or less. This finding is supported by Fausset *et al.* (2013) who found that the initial attitude of users toward wearable devices for self-monitoring of activity levels was positive, but they stopped using it after a one to two-week period. Therefore, this study examines the factors influencing the behavioural intention of overweight adults to make long term use of wearable devices for sustained health monitoring. The subsequent section explains the problem statement.

1.2 Problem Statement

The volume of wearable devices that can be used for health monitoring purposes is continuously growing within the healthcare sector. These devices allow users to track their own activity levels in real time. However, the integration of these devices into users' daily life presents an array of challenges such as privacy concerns, reliability as well as aesthetics properties (Piwek, Ellis, Andrews, & Joinson 2016; Rapp, & Cena, 2015). Maintaining an active lifestyle through the use of wearable devices is vital for overweight adults in order to improve their activity levels, but persuading them to utilise the device on a long term basis remains a difficult issue (Chen *et al.*, 2016). Jakicic *et al.* (2016) found that when overweight users start using wearable devices, they only used them for a short period of time. There has been an open demand for research into the behavioural intention to use wearable devices, but only a few studies have explored this area of research thus far (Bice, Ball, & McClaran, 2015; Wiederhold, 2015).

Agudo-Peregrina, Hernández-García, and Pascual-Miguel (2014) examined behavioural intention as the individual's conscious procedures to act or behave in a certain way, thereby leading to a process in which overweight adults could choose and use wearable devices for sustained health monitoring. According to Ledger (2014), the continued use of wearable devices goes beyond adoption by overweight adults, and extends to ensuring that the device can make a long-term impact on a user's lifestyle and health. Wearable devices are "products and services that provide utility, but fail to have a meaningful impact on users' behaviours and habits -- such as an activity tracker that provides data, but doesn't inspire action -- ends up failing in the market" (Ledger, 2014, p. 5). Pels, Kao and Goel (2014) express that medical solutions such as wearable devices for overweight adults' have been accessible, but the long-term impact of behavioural intent has not yet been established, which makes it difficult to prompt the desired behaviour over a short period of time. On the other hand, Turhan (2013) argue that collective responses of wearable devices can be inhibited according to the user's behavioural intentions which can also be employed to boost the expressive capabilities of the user. Thus, there is need to address the behavioural intention of overweight adults to make use of wearable devices and how it can influence sustained health monitoring. The following section addresses the primary research question and its sub-questions.

1.3 Primary Research Question

The primary research question to be examine in this research study is as follows:

How can the behavioural intention of overweight adults in South Africa to make use of wearable devices be influenced for sustained health monitoring?

1.4 Sub-Research Questions

The primary research question was investigated with the help of three research sub-questions:

1. **How can wearable devices improve the lifestyle of overweight adults in South Africa?**

This section investigates the effectiveness and importance of wearable technologies to improve overweight adults' lifestyles. According to Pureprofile (2015), wearable activity trackers are gaining widespread adoption and this provides an opportunity to incorporate such devices into physical activity interventions. Commercially available activity levels tracking devices allow real-time support and feedback for health related behavioural change among users (Mercer *et al.*, 2016). This question also identifed benefits and characteristics of wearable devices and persuasive technologies available to patients.

2. **What types of wearable devices exist to support health monitoring?**

This sub-question identified and discussed the various types of wearable technologies that exist to support health monitoring. Wearable devices are increasingly gaining popularity. There are various wearable devices available in the market, ranging from smart watches, clothes, glasses, shoes and fitness trackers. Guo, Li, Kankanhalli, and Brown, (2013), evaluated various wearable health monitoring devices that are presently in the market that can be used to efficiently track individual activity levels. Evenson, Goto and Furberg (2015) identified the Fitbit as one of the several wearable devices available in the market that has shown potential in influencing adherence to self-tracking of activity levels in different populations.

3. **What factors will influence behavioural intention of overweight adults to use wearable devices for self-monitoring?**

This sub-question examined factors influencing the behavioural intention of overweight adults to use wearable devices for self-monitoring. Wearable devices have the potential to support self-monitoring by compiling, storing, tracking and providing responses about users' activity levels (Fausset *et al.*, 2013). In a study by Fausset *et al.* (2013), the initial attitude of users toward wearable devices for self-monitoring revealed positive activity levels, but they stopped using them after a one to two-week period.

1.5 Objective of the Study

The primary aim of this study was to examine the factors that would influence behavioural intention of overweight adults in South Africa to make use of wearable devices for sustained health monitoring. According to Ledger (2014), the basis for a favourable outcome for wearable devices goes beyond adoption to an extent which it can have a long-term influence on overweight adults' lifestyles and health.

1.6 Significance of the Study

The study is important as it developed a framework showing factors influencing behavioural intention of overweight adults to continue using wearable devices for sustained health monitoring. The outcome of this study will serve as a reference for users of wearable devices, healthcare providers and the Department of Health in South Africa on how to improve the health outcomes of overweight adults.

Wearable devices are closely connected with an emerging healthcare delivery system. With this new trend, self-monitoring devices allow individuals to monitor their health without having to visit a health care facility (Prakash, 2016). Wearable devices allow overweight adults to assume control of their health condition through sustained health monitoring. Wearable devices can enhance activity levels in order to manage the weight of users. This is particularly relevant in developing countries where healthcare systems are overburdened and under resourced.

1.7 Preliminary Literature Review

The use of wearable devices for self-monitoring is continuously growing within the healthcare sector, allowing individuals to track their own activity levels in real time (Rapp, & Cena, 2015). Wearable devices put users' personal health data in their own hands, allow them to take control of their daily activity levels and provide in-depth information to make decisions that can affect their lifestyles (Farmanfarmaian, 2014). Case, Burwick, Volpp, and Patel (2015) identified wearable devices worn around the wrist, installed on a wristwatch or in a mobile phone, as a special sensor that tracks daily activity levels of patients. Wearable activity devices are an emerging solution that provides support for physical activity levels as well as offering guidance on patients' health (Mercer, Li, Giangregorio, Burns, & Grindrod, 2016). PricewaterhouseCoopers [PWC] (2016) conducted a survey on wearable technology that identified Progressive Insurance, Discovery Vitality, the Virgin Atlantic, Momentum Multiply and the Container Store as encouraging the use of wearable devices usage in the Republic of South Africa. Furthermore, overweight adults who are members of these health insurance providers could earn rewards by using a wearable device to monitor their daily activity. Fisher (2016) identified four benefits of wearable devices; these benefits were real-time data collection, continuous monitoring, predicting and alerting, as well as empowering patients in an unprecedented way.

Cognizant (2014) classified wearable devices into five categories: infotainment, lifestyle, fitness, gaming and medicals. Different types of wearable devices include smart fabrics and e-textile, contact lenses, glasses, headbands, and bracelets which enhance communication capability (Kiana, & Michael, 2014). Figure 1.1 illustrates the spectrum of wearable devices. Although there are different types of wearable devices, this study will focus on familiar self-monitoring activity tracking devices worn around the wrist. Examples of some wearable devices worn around the wrist include Fitbug, Jawbone, Polar device, Fitbit, Garmin Connect, and other apps (PWC, 2016). Evenson *et al.*, (2015) identify Fitbit as one of the several wearable devices available in the market that has shown potential in influencing adherence to self-tracking of activity levels in different populations. The wearable devices can typically track weight, active minutes, milestones, calories burned, distance, steps, floors climbed, as well as create goals for the patient (RunKeeper, 2013; Fitbit, 2015).

Figure 1.1: The Spectrum of Wearable Devices (Cognizant, 2014)

Wearable devices open up new possibilities in self-monitoring of patients' daily activity levels. Abraham, Chow, and So (2014) state that research into wearable devices to improve patients' lifestyle, weight-related behavioural change and self-monitoring has grown in recent years. According to Gilmore (2015), wearable devices influence active lifestyles for patients to monitor their physical activities as well as display information relating to their health behaviour for sustained health monitoring. Self-monitoring technology can promptly prevent a patient's illnesses. With the growth of wearable devices, patients' ability to self-monitor has increasingly become ubiquitous (Keikhosrokiani, Mustaffa, Zakaria, & Baharudin, 2015).

Research on technology healthcare in connection to continuance intention to use has been examined extensively and indicating behavioural intention as a clear-cut predictor in information technologies continuance intention (Ram, Park, & Chung, 2014; Deng, Mo, & Liu, 2013; Venkatesh, Davis, & Morri, 2007). The study done by Ram *et al.* (2014) indicated that users' intentions on continuance usage of mHealth tools could be determined by users' attitudes. Also, factors such as user engagement, motivation and goal settings have been identified to influence sustained health monitoring (Rooksby, Rost, Morrison, & Chalmers, 2014; Shih, Han, Poole, Rosson, & Carroll, 2015). Rooksby *et al.* (2014) explain the influence of personal motivation on the use of wearable devices for self-monitoring and recommend that more research should be conducted into a patient's preferences for sustained health monitoring. Additionally, Kim, and Park, (2012), identify perceived expectation, ease of use, performance and usefulness significantly affect users' continuance intention and attitude to use health applications. Section 1.8 explains the underlying theory of this study.

1.8 Theoretical Perspective

This research adopted the Expectation Confirmation Model (ECM) developed by Bhattacherjee (2001b). The ECM originated from the Expectation Confirmation Theory (ECT). The ECT was originally proposed by Oliver (1980) in marketing research, mostly to analyse consumer repurchase behaviour and satisfaction. Expectation Confirmation Theory was conceptualised from Cognitive Dissonance Theory, generally applied in studying service continuance and product post purchase by researchers to describe users' repurchase intention and satisfaction (Yang, Lu. & Chau, 2013). Bhattacherjee (2001b) developed and tested the ECM based on the Technology Acceptance Model (TAM) and Expectation Confirmation Theory (ECT). The ECM was one of the foremost research tools to be used to examine the distinction between technology acceptance and Information Systems (IS) continuance intention. The ECM is formulated based on four main constructs: confirmation, perceived usefulness and satisfaction leading to IS continuance intention. Figure 1.2 below depicts the theoretical perspective for this study.

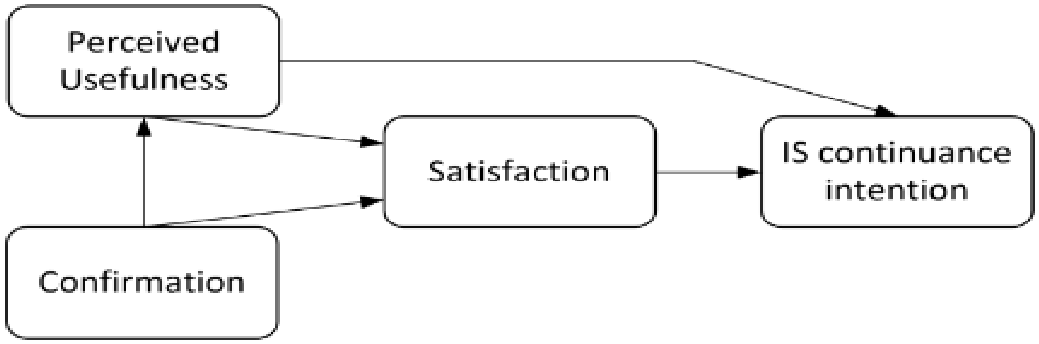


Figure 1.1: The Expectation Confirmation Model (Bhattacherjee, 2001b)

Confirmation refers to the coherence between the expectation and its actual results, while perceived usefulness explains users' judgement of the expected outcome from IS usage (Bhattacherjee, 2001b). Also, satisfaction of IS actual performance posits IS continuance intention. Finally, the constructs in Figure 1.2 may tend toward continued IS usage, while the disparity between perceived benefits and expectations determines the disconfirmation or confirmation level. The ECM is mostly centred on post-acceptance elements because it postulates that the outcome of any post acceptance elements are already accomplished within the satisfaction and confirmation elements (Bhattacherjee, 2001a). The ECM has been used in studies such as adoption and continued usage of radio frequency identification (Hossain, & Quaddus, 2011); online banking users (Bhattacherjee, 2001a) and the usage of mobile data service (Chen, Liu, & Lin, 2013). Nematolahi, Kafashi, Sharifian, and Monem (2017) investigated users' continuous intention to use picture archiving and a communication system in a teaching hospital. Findings from the study indicated that perceived usefulness, expectation confirmation and satisfaction were factors influencing intention of medical practitioners to use picture archiving and communication systems.

In application to this study, overweight adults should be able to form initial expectations about use of wearable devices for sustained health monitoring which, in turn, could initiate perceived usefulness of the devices. Afterwards, the users of the devices should be able to assess if there is coherence between the initial expectation and the actual benefits from wearable devices usage for sustained health monitoring. Thereafter, the outcomes of assessment of the usage will determine continued or discontinued future use of wearable devices by overweight adults. Thus, the use of ECM will provide a better knowledge and understanding of the factors that will influence overweight adult's intentions to use wearable devices for sustained health monitoring. The next section discusses the research design and methodology for this study.

1.9 Research Design and Methodology

Research design is the process of turning research objectives and questions into a research project. It involves all the steps needed to achieve the outcome of a research project (Saunders, Lewis, & Thornhill, 2016). The next section explains the research paradigm after which the research method, design, population and sample, data collection, data analysis and data trustworthiness will be discussed.

1.9.1 Research paradigm

A research paradigm is a common framework for research and theory that consists of fundamental premises, essential issues, as well as a description of quality research (Neuman, 2013). A paradigm is a technique of analysing social phenomena from which specific perspectives can be acquired (Saunders *et al.*, 2016). Thus, it is important to note that paradigms play a vital role in the social sciences. Figure 1.3 explains the choice of paradigm adopted for this study.

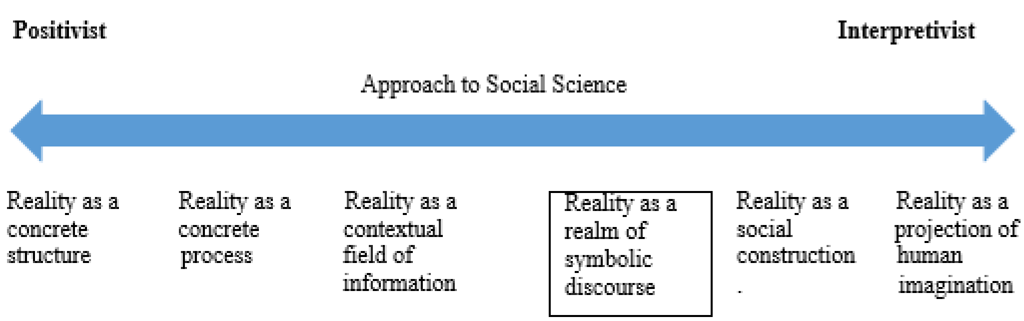


Figure 1.3: Continuum of Core Ontological Assumptions (Collis, & Hussey, 2013)

Research is often classified based on polarisation: that is interpretivist or positivist and quantitative or qualitative (Clough, & Nutbrown, 2012). As identified in Figure 1.3, the positivist and interpretivist approaches distinguish the two extremes of research paradigms with various approaches within the continuum (Collis, & Hussey, 2013). The interpretivist approach focuses on analysing social phenomena with a view of acquiring clearer insight and meaning attached to such phenomena (Collis, & Hussey, 2013). Thus, this research aligns with the interpretivist approach and the 'reality as a realm of symbolic discourse' element on the continuum of core ontological assumptions. The qualitative research design is relevant for this study because it will allow the researcher to understand the subjective meanings of behavioural intention of overweight adults to make use of wearable devices for sustained health monitoring. The following section will explain the research method of this study.

1.9.2 Research method

This study adopted the qualitative research method which is consistent with the interpretivist approach (Saunders *et al.*, 2016). According to Mertens (2010), the qualitative approach is formulated to provide an in-depth detail of specific procedures in terms of the meaning people give to them. The qualitative approach includes inductive logic, discovery, contextual, complexity, exploration and selection of a variety of empirical materials (Mertens, 2010). These are important as they allow the researcher to understand the factors influencing behavioural intention of overweight adults' to make use of wearable devices for sustained health monitoring. This study used literature reviews as well as semi-structured interviews to answer the identified research problem.

1.9.3 Research design

The research design is a blueprint or map, a pattern to collect, determine and evaluate data (Sekeran, & Bougie, 2013). A research design allows researchers to choose or disseminate to others the outcome of the proposed study, as well as the process of information gathering from respondents and how the research findings will be communicated (Kumar, 2014). This study used the qualitative research method as well as semi-structured interviews to obtain information from respondents. According to McNamara (1999), interviews are particularly important for obtaining information behind a respondent's experience. Interviews provide the researcher with the opportunity to pursue a thorough understanding of the topic and to further explore participants' responses. Dawson (2007) argues that the semi-structured interview is mostly used in a qualitative study.

For this study, a semi-structured interview was effective in obtaining deeper insights into how overweight adults' behavioural intention to make use of wearable devices could be influenced for sustained health monitoring. A pre-established set of questions in the semi-structured interview by the researcher further provided information on issues relating to behavioural intention to make use of wearable devices. The interview questions were adapted from the ECM in order to answer the research questions (Oliver, 1980; Bhattacherjee, 2001a). Respondents were recruited for this study through email and print advertisements. The purpose of the interviews was to understand the factors that influence behavioural intention of overweight adults' to make use of wearable devices for sustained health monitoring.

1.9.4 Population and sample

The research objectives and peculiarity of the study population determine the size and diversity of respondents to be selected (Creswell, 2014). The population that was used for this research project were overweight adults who are users of fitness tracking devices in East London, South Africa. Keikhosrokiani *et al*. (2015) used respondents who are smartphone users to study users' behavioural intention toward a mobile healthcare system.

The sample size for the study participants was 20 overweight adults and users of fitness tracking devices from ages 18 – 59, living in East London, South Africa. Overweight was determined by using the respondents' body mass index (BMI). The WHO (2016) guidelines state that people with a BMI between 25 kg/m^2 and 29.9 kg/m^2 can be considered to be overweight. The BMI was determined by dividing the respondent's weight by his/her height. All volunteer respondents were asked for permission to measure their weight and height prior to the start of the study. This was explicitly specified in all recruitment materials.

The researcher employed a purposive sampling technique to identify the overweight participants. The purposive sampling method is a form of a non-probability sampling method in which a researcher consciously and purposively chooses participants that he/she considers to have knowledge of the study questions (Lewis, & Sheppard, 2006). The next section explains the data analysis for the study.

1.9.5 Data collection

Data collection is an essential aspect of any research study. Information obtained is determined by the analytical approach and methodology used to produce the research findings (Paradis, O'Brien, Nimmon, Bandiera, & Martimianakis, 2016). This study used both primary and secondary data to answer and analyse the research question. Furthermore, primary data has to do with collection of data from respondents of the study, while secondary data is referred to as the collection of existing data and methods from sources such as reports, documents, academic journals, books, and conference proceedings. In this study, electronic databases such as PubMed, Science Direct, Journal of Medical Internet Research (JMIR), ResearchGate, ACM Digital Library, Google Scholar and others were used to find significant literature.

The primary data collection tool for this study was semi-structured interviews which were used to collect information directly from purposively selected overweight adults in East London. A pre-established set of questions in the semi-structured interview conducted by the researcher further provided information on issues relating to behavioural intention to make use of wearable devices. The ECM constructs were used to determine the factors influencing behavioural intention of overweight adults to make use of wearable devices for sustained health monitoring. The participants' personal data collected through the wearable device were not considered in the study.

1.9.6 Data analysis

Guest, MacQueen and Namey (2012) define thematic analysis as the most commonly used analysis method linked with qualitative studies. Thematic analysis provides a robust and accurate approach to data analysis in qualitative studies. Thematic analysis is mostly used for documenting patterns or themes, examining, pinpointing and identifying meanings within data (Braun, & Clarke, 2006). Also, it is considered as most applicable for any research that aims to discover contextual meaning and interpretations. Marks and Yardley (2004) state that thematic analysis provides an opportunity to know the potential of any issue more broadly.

Thus, this study adopted thematic analysis to investigate how overweight adults' behavioural intention to make use of wearable devices could be influenced for sustained health monitoring. The data provided by respondents were organised into relevant themes in describing and linking the relationship between the data collected and the findings of this research. The six phases of data analysis developed by Braun and Clarke (2006) were used during the analysis process. These phases include familiarisation with data, generating initial codes, searching for themes, reviewing themes, defining and naming themes as well as producing the report. The following section discusses the data trustworthiness of the research study.

1.9.7 Data trustworthiness

The advantage of a qualitative study is the richness of information obtained from respondents and such data must be transcribed in a well-grounded and valid method (Moretti et al., 2011). According to Lincoln and Guba (1985), trustworthiness of a research study is essential in assessing its quality. Trustworthiness of data is determined by four criteria: credibility, transferability, dependability and conformability.

According to Trochim and Donnelly (2007: p.149), "credibility involves establishing that the results of qualitative research are credible or believable from the perspective of the participants in the research". Mertens (2010) explains that findings from a study must be based on adequate data collection as well as effective data analysis and interpretation. With regards to credibility, data collected from academic journals, articles and the interview responses from overweight adults were analysed effectively to support the validity of this study.

Transferability is an extent to which the outcome of qualitative study can be reciprocated by other perspectives or backgrounds (Trochim & Donnelly, 2007). Transferability in research allows the applicability of findings of a particular study to be transferred to another research context. Also, Lincoln and Guba (1985) describe transferability as an idea that allows readers of a study to make evaluations based on uniformity and differences when contrasting the study to their own. The theoretical perspective, research design and methodology of this study can be replicated hopefully in another context in future research.

Dependability is the qualitative parallel to authenticity of research findings (Lincoln & Guba, 1985). Dependability emphasises the appropriateness of findings over time and under different circumstances. Moretti *et al.* (2011) state that it is essential to clearly explain methods and bases used to choose respondents and present the respondents' key attributes. Relevance and quality of a research study can be confirmed through a dependability audit (Mertens, 2010). Therefore, this study strictly followed the best practices of qualitative studies by ensuring that personal views of the researcher did not interfere with data collection and analysis of the study.

Conformability emphasises the level to which the research findings could be authenticated or validated by others (Trochim & Donnelly 2007). Also, Mertens (2010) explains conformability as the researcher's ability to trace data collected to their original source, while the logic adopted to explain the data collected must be without any form of ambiguity. With regards to conformability, the research findings conformed to existing knowledge and the researcher was not subjective in the collection and analysis of data. The following section discusses the delimitation of the research study.

1.10 Delimitation of the Research Study

This study focused on behavioural intention of overweight adults to use wearable devices for sustained health monitoring over a long term. The study participants were limited to overweight adults, aged between 18-59 years, living in East London, South Africa. The study was limited to 20 respondents. The next section explains ethical considerations of this study.

1.11 Ethical Considerations

According to Kumar (2014), ethics deal with beliefs about what is appropriate or inappropriate when conducting a research study. Thus, participants were informed of the advantages and disadvantages of the study and their permission was requested before commencing the study. Only volunteer participants older than 18 years were used for the purpose of this study. The participants' personal data collected through the wearable device were not used for the purpose of this study, only the behavioural intention of the participants to use the wearable devices was investigated. The research was carried out in accordance with the academic guidelines of voluntary participation. The participants were assured of their confidentiality and anonymity during and after the study. This research conformed to the ethical guidelines specified by the University of Fort Hare Research Ethics Committee. Thus, this study acquired an ethical clearance from the University of Fort Hare Research Ethics Committee before the researcher embarked on data collection. The following section shows the chapter outline of this study.

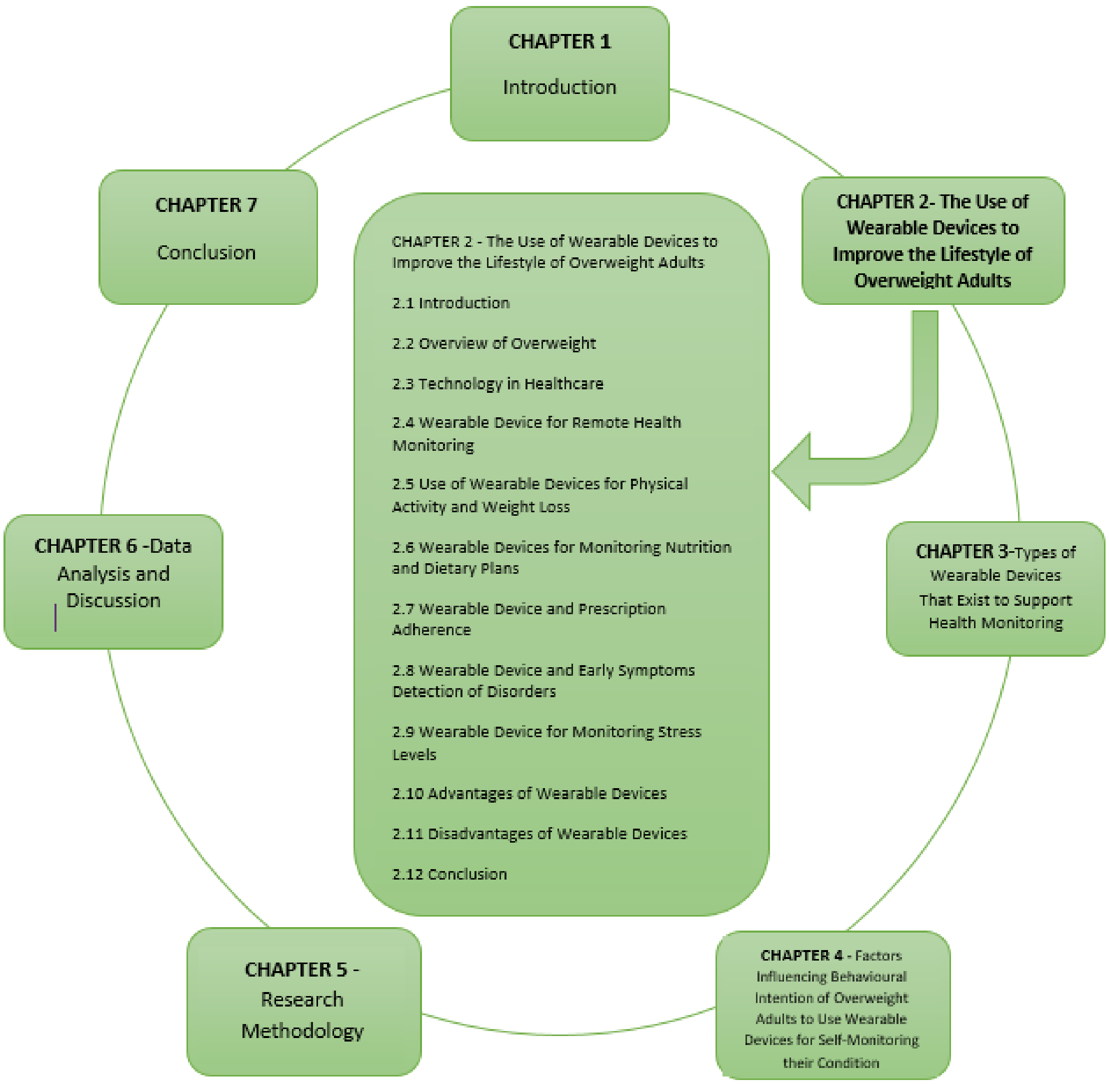
1.12 Chapter Outline

This section highlights the proposed chapter outline for this research:

Table 1.1: Outline of Chapters

CHAPTER	SECTION
Chapter One	Introduction
Chapter Two	The use of wearable devices to improve the lifestyle of overweight adults
Chapter Three	Types of wearable devices that exist to support health monitoring
Chapter Four	Factors influencing behavioural intention of overweight adults to use wearable devices for self-monitoring of their condition
Chapter Five	Research Methodology
Chapter Six	Data Analysis and Discussion
Chapter Seven	Concluding Chapter

CHAPTER 2


CHAPTER 1
Introduction
CHAPTER 2- The Use of Wearable Devices to Improve the Lifestyle of Overweight Adults
CHAPTER 3-Types of Wearable Devices That Exist to Support Health Monitoring
CHAPTER 4 - Factors Influencing Behavioural Intention of Overweight Adults to Use Wearable Devices for Self-Monitoring their Condition
CHAPTER 5 - Research Methodology
CHAPTER 6 -Data Analysis and Discussion
CHAPTER 7
Conclusion
CHAPTER 2 - The Use of Wearable Devices to Improve the Lifestyle of Overweight Adults
2.1 Introduction
2.2 Overview of Overweight
2.3 Technology in Healthcare
2.4 Wearable Device for Remote Health Monitoring
2.5 Use of Wearable Devices for Physical Activity and Weight Loss
2.6 Wearable Devices for Monitoring Nutrition and Dietary Plans
2.7 Wearable Device and Prescription Adherence
2.8 Wearable Device and Early Symptoms Detection of Disorders
2.9 Wearable Device for Monitoring Stress Levels
2.10 Advantages of Wearable Devices
2.11 Disadvantages of Wearable Devices
2.12 Conclusion

The Use of Wearable Devices to Improve the Lifestyle of Overweight Adults

2.1 Introduction

The 21st century medicine remains a technologically driven era with the emergence of wearable technology that helps users to become more aware of their lifestyles. Chapter 1 identified self-monitoring as a key determinant in the management of lifestyles of overweight adults. Wearable devices have a positive impact on overweight adults' health and wellness, offering a possible solution to improving their activity levels. However, how to motivate them to utilise the device remains a difficult issue (Chen *et al.*, 2016). Thus, this research examines how the behavioural intention of overweight adults to make use of wearable devices can be influenced for sustained health monitoring.

This chapter extensively discusses how wearable devices can improve the lifestyle of overweight adults. The first section provides an overview of overweight adults. The next section discusses technology in healthcare. The last section explains different purposes of wearable devices for remote health monitoring, physical activity and weight loss, nutrition and dietary monitoring, eating and food-intake activity monitoring, food data and record collection, prescription adherence, early symptoms detection as well as monitoring stress levels.

2.2 Overview of Overweight

According to the National Department of Health South Africa [NDoH] (2015), "Overweight and obesity reflect a gain of excess body fat, resulting from the cumulative and initially unnoticeable effects of day-to-day eating and physical activity behaviours that create a surplus of energy consumed relative to expended" (p. 21). The rising occurrence of overweight adults is associated with a number of non-communicable cardiovascular diseases such as hypertension, high cholesterol, joint pain, heart disease, type 2 diabetics, stroke, and in some cases, cancers (Coughlin & Stewart, 2016). The WHO (2016) guidelines state that people with a body mass index (BMI) greater than 25 kg/m^2 can be considered to be overweight. The BMI is commonly used to specify ranges related to health risk from underweight individual with < 24.9 kg/m2 to overweight individual with > 24.9 kg/m2. The WHO (2011) classification of BMI will be used to determine overweight adults for this study as depicted in table 2.1. The formula for BMI is determined by dividing weight by height.

Table 2.1: Classification of overweight and obesity *BMI* (Adapted from WHO, 2011)

Classification	BMI (kg/m2)	Risk of co-morbidities
Underweight	<18.5	Low
Normal	18.5-24.9	Average
Overweight	>25	
Pre-obese	25-29.9	Increased
Obesity (class I)	30.0-39.9	Moderate
Obesity (class II)	35.0-39.9	Severe
Extreme obesity (class III)	>40.0	Very severe

Approximately 1.9 billion adults older than 18 years of age are considered overweight worldwide, which affects both their lifestyles and health (WHO, 2016). The number of overweight adults in South Africa has continued to increase over time, affecting 56% adults in 2002 and 65% in 2012 respectively (Puoane, *et al.*, 2002; Shisana, *et al.*, 2013). Also, the findings of Malambo, Kengne, Lambert, Villiers and Puoane (2016) revealed that 45% adults were physically inactive in South Africa, with physical inactivity being ranked 9th among risk factors for mortality in South Africa.

The WHO (2016) and Health Promotion Board (2016) identified the imbalance between energy expenditure and intake as the major cause of becoming overweight. In addition, studies have established a positive link between an increase in certain lifestyle factors and body weight such as cultural influence, family income, sedentary lifestyle, advertisement on food preferences, high sugar consumption and consumption of fast food (Alrashidi, 2016; Poti, Duffey, & Popkin, 2014; Herman *et al.*, 2014; Al Alwan, Al Fattani, & Longford, 2013; Malik, Pan, Willett, & Hu, 2013; Wang *et al*., 2013; Boyland, & Halford, 2013; Green *et al*., 2003).

A healthy diet is required to prevent the accumulation of body fat. Eating healthy foods entails adherence to appropriate dietary rules as well as the ability to select the correct diet and control the quantity of food intake in order to lose weight (Yusof, & Iahad, 2012). Overweight adults need adequate nourishment through maintaining a healthy lifestyle and balanced diet (National Health and Medical Research Council, 2016). This can be achieved through the self-monitoring method which has been proven as the most efficient means to manage weight loss. The subsequent sections explain the causes, complications and treatments of overweight people.

2.2.1 Causes of being overweight

Overweight represents an increasing threat to the health of people in developed and developing countries (WHO, 2016). The prevalence of overweight people has become a challenge related to under nutrition and hunger for many developing nations (Keding, Msuya, Maass, & Krawinkel, 2013). The NDoH (2015) identified a lack of education, the built environment, urbanisation, wealth inequity and poverty as factors responsible for the rising overweight population in South Africa. This section provides a description of the most common risk factors associated with the prevalence of overweight people.

1. ***Sedentary behaviour*** – It is characterised by any activities that involve low energy expenditure such as lying down, sitting and spending more time in front of screen-based gadgets [tablets, mobile phone, computer and television] (Teychenne, Costigan, & Parker, 2015; Sedentary Behaviour Research Network 2012). A sedentary lifestyle is associated with physical inactivity and immobility as a result of an inadequate amount of physical activity among overweight adults during the day (Poti *et al.*, 2014).

2. ***Stress*** – Torres, and Nowson (2007), describe stress as “the generalised, non-specific response of the body to any factor that overwhelms, or threatens to overwhelm the body’s compensatory abilities to maintain homeostasis or stability” (p. 1). Discovery Centre for Health Journalism (2013) identify stress in the workplace as a major contributing factor to prevalence of weight gain among adults. To this end, the effect of stress can severely affect food preference and eating patterns such as eating more snacks and fast foods which usually contain high calorie density (Tahir, 2016; Sinha, & Jastreboff, 2013).

3. ***Dietary behaviour*** – Patterson, Risby and Chan (2012) and Poti *et al*. (2014) identify consumption of unhealthy food, large portion size, inadequate vegetable and fruit intake as

well as frequent intake of sugar-sweetened drinks as major factors contributing towards weight gain. Steyn, Nel, Parker, Ayah and Mbithe, (2012) associated regular purchase of foods at spaza shops by the majority of South African citizens to be a predictor of overweight among adults.

4. ***Genetic factors*** – Research findings by Liu, Mou and Cai (2013) acknowledged that genetic factors play a significant role in relation to weight gain, which may result in higher chances of overweight occurrence among adults. The increase rate of weight gain is as a result of interaction between genetic susceptibility and environmental factors that have changed due to health transition and global nutrition (Demerath, 2012). In addition, the NDoH (2015) identifies four leading causes of overweight and obesity: poor early childhood feeding practices, insufficient physical activity, poor diet and lack of knowledge. This is depicted in the drivers of overweight and obesity in Figure 2.1 below.

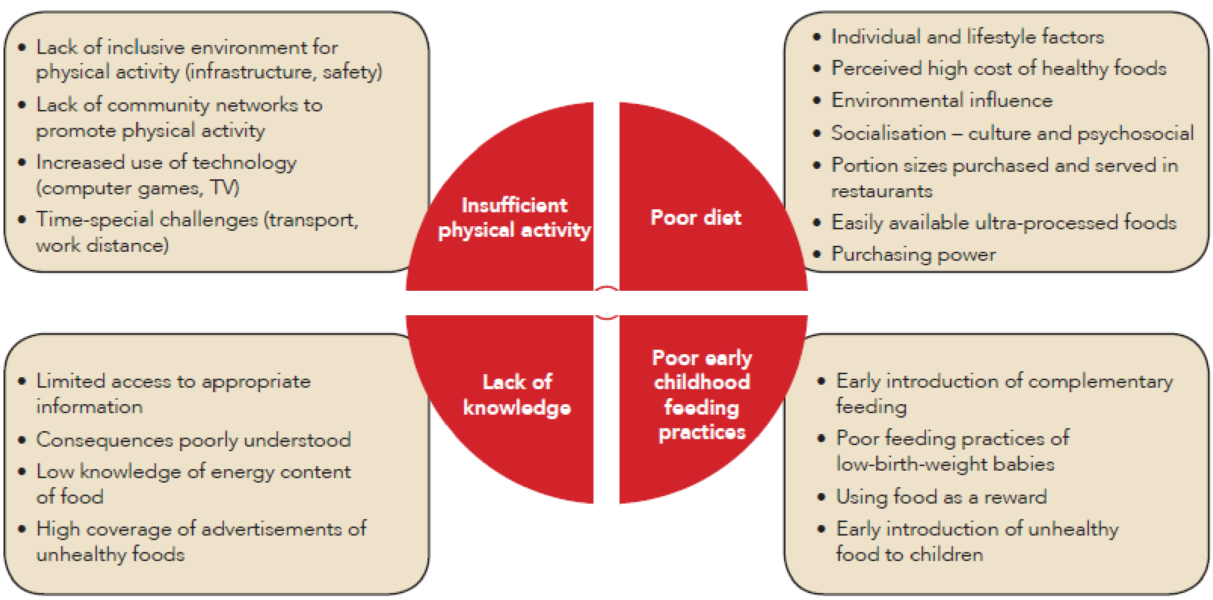


Figure 2.1: Drivers of Overweight and Obesity (The NDoH, 2015)

2.2.2 Complications of being overweight

According to Bhaskaran, Douglas, Forbes, dos-Santos-Silva, Leon and Smeeth, (2014), overweight adults are at risk of many health conditions and diseases compared to those with healthy or normal weight. Some of the health risks related to overweight will be briefly discussed as follows:

1. ***High Blood Pressure*** – Being overweight is linked with high blood pressure which affects approximately 22% of adults from the age of 18 and above, worldwide (WHO, 2014). Excess weight gain may raise blood pressure because the heart is required to pump harder to give blood to all the body cells.

2. ***Cancer*** – A study conducted by the International Agency for Research on Cancer [IARC] (2017), identify a high prevalence of 13 different types of cancer to being overweight. This includes breast, colon, endometrial, esophageal, gallbladder, kidney, liver, meningioma, multiple myeloma, ovarian, pancreatic, stomach and thyroid cancer. Fatty cells may supply hormones that affect cell growth, thereby increasing the risk of cancer (Klein, 2017).

3. ***Type 2 diabetes*** – Being overweight can be linked to insulin resistance in the body as a result of an unhealthy meal plan which may cause the cells to gradually fail (Leontis, & Hess-Fischl, 2017). This may eventually lead to the symptoms associated with type 2 diabetes.

2.2.3 Treatments for overweight people

The aim of treatment is to attain and stay at a healthy weight (Mayo Clinic, 2015). Risk factors associated with overweight adults can be prevented if adequate actions are taken to bring about a balance in energy intake and expenditure (Shimokawa, 2013). Increased physical activity, dietary, sedentary behavioural changes, as well as weight loss medications and surgery, were identified by Mayo Clinic, (2015) as an effective approach for treating overweight adults.

1. ***Dietary changes*** – Enhancing dietary knowledge can help overweight adults change their eating style to achieve a balanced weight (Wagner, Rhee, Honrath, Salafia, & Terbizan, 2016). Thus, the achievement of a balanced weight has become a vital aspect in overweight and obesity prevention strategies among governmental and international organisations (WHO, 2016; NDoH, 2015; Discovery Centre for Health Journalism, 2013).

2. ***Physical activity and exercise*** – One needs to take into cognisance the advantages of physical activity and its major health benefits for ameliorating the risk factors associated with excess weight gain. Engaging in a physical activity and exercise of moderate-intensity for 60 minutes daily is a significant step toward maintaining a healthy weight as well as preventing chronic diseases (WHO, 2016). Additionally, Melzner, Heinze, and Fritsch, (2014), recommend moderate intensity aerobic physical activity for a minimum of 150 minutes weekly or vigorous-intensity aerobic activity for not less than 75 minutes weekly. Therefore, physical activity has been shown to reduce the risk of hypertension, cancer, type 2 diabetes and other complications linked to excess weight gain (Gray, Macniven & Thomson, 2013; Schoenborn, & Stommel, 2011).

3. ***Sedentary behavioural changes*** – The Mayo Clinic, (2015), behavioural modification program can assist overweight adults to make changes to their sedentary lifestyle and lose weight. This can be achieved by finding out current risk factors that may have contributed to the weight gain. Research carried out by Cooley, and Pedersen, (2013), identified the use of technology-based reminders to help overweight adults to avoid a sedentary lifestyle.

4. ***Weight loss medication*** – Prescription of weight-loss medication can be introduced to help prevent further weight gain in certain situations where previously identified preventions have been unsuccessful. Although the effectiveness of the few drugs available for overweight adults' treatment is limited to maintenance of weight reduction rather than cure (Mead, *et al.*, 2016; Bray, 2011).

5. ***Surgical intervention*** – Weight-loss surgery, also known as bariatric surgery is the most effective and current clinical practice in the treatment of severe weight gain among adults (Styne, *et al*., 2017). This form of treatment may be considered if other identified methods to lose weight have not worked or were unsuccessful (Mayo Clinic, 2015). To this end, technology has been identified in order to help overweight adults with the treatments explained in this section as well as management of their lifestyles. The next section will discuss the role of information technology in healthcare.

2.3 Technology in Healthcare

The use of digital technologies for sustained health monitoring is currently supported amongst many developed and developing nations (Currie & Seddon, 2014). Information and Communication Technologies (ICTs) are considered as innovative solutions to improve individual lifestyle and healthcare systems (Gaddi & Capello, 2014). Healthcare technology, such as mobile apps and wearable devices, are increasingly being promoted as a means of improving sustained health monitoring as well as enhancing patients' engagement (Frist, 2014). Application of technology to support healthcare may, for example, enhance behavioural change; physical activities; medication adherence; and help patients' self-monitoring.

2.3.1 Electronic Health

Electronic health (eHealth) is the combined utilisation of ICT and related technologies for delivery of healthcare across entire health systems (Varshney, 2014; Eysenbach, 2001). Electronic health serves as a link between the non-clinical and clinical aspect in healthcare systems as well as health-oriented tools. Healthcare specialists use eHealth to make timely clinical decisions concerning patient care in the interest of advancing the health of individuals and their communities. Electronic health can be categorised into a variety of sub-sets of digital health such as: electronic health records (EHRs), telemedicine, sensors and wearable devices, health information technology systems (HITSs), mobile health (mHealth) and big data systems (Innovatemedtec [IMT], 2017a):

1. ***Electronic health records*** – EHRs are the systematic collection of patients' medical histories at any given time via digital means (Katurura & Cilliers, 2016). An EHR provides a comprehensive view of a patient's health records allowing healthcare providers to track information in real-time (Canada Health Infoway, 2013). The application of EHRs in health monitoring can enhance users' experiences and engagement in tracking their daily lifestyle, by using reminders and alerts (Chiauzzi, Rodarte & DasMahapatra, 2015).

2. ***Telemedicine*** – Telemedicine can be defined as the exchange of medical information through electronic communication to provide remote healthcare for a patient (Okrent, 2015). These include utilisation of wireless tools, smart devices, two-way video, email and

other types of telecommunication technology. Pavlovskaya (2013) articulated that telemedicine has made it convenient for healthcare professionals to utilise a variety of electronic applications such as telesurgery, telecare, and teleconferencing. Telemedicine sometimes can be used interchangeably as telehealth.

3. ***Health IT systems*** – Health IT systems can be described as “the application of information processing within digital health, involving both computer hardware and software that deals with the storage, retrieval, sharing, and use of healthcare information, data, and knowledge for communication and decision-making” (IMT, 2017b, p.1). Health IT is adopted in order to increase productivity and efficiency of healthcare systems as well as improve access to affordable care.

4. ***Big data systems*** – The rapidly expanding field of big data to analyse large amounts of data has emerged to play a significant role in the development of healthcare research and practices (Belle, *et al.*, 2015). These huge datasets span among government departments, multiple healthcare providers, health insurers and researchers (Groves, Kayyali, Knott & Van Kuiken, 2013). Big data serves as a tool for managing, accumulating and assimilating unstructured and structured data put together by current healthcare systems.

5. ***Mobile Health*** **–** mHealth forms the largest proportion of eHealth services (Keisling, 2014). mHealth extends to diverse sophisticated technologies that deal with illness prevention and wholeness of health, tracking and care of patients outside the conventional clinical environment (Varshney, 2014). Mobile Health applications are commonly used for remote monitoring, healthcare supply chain management, chronic diseases’ management, epidemic outbreak tracking safety as well as wellness interventions (IMT, 2017a).

6. ***Sensors and wearable devices*** – Current advance in technologies, data analysis techniques and sensor manufacturing have unveiled unique potentials for using sensors and wearable devices in the healthcare ecosystem to accomplish a wide range of health outcomes (IMT, 2017a). Wearable devices can be unified into diverse accessories such as smartphones,

headphones, wristwatches, eyeglasses, shoes, band, socks, wrist, hats and garments for sustained health monitoring (Majumder, Mondal & Deen, 2017). The different types of wearable devices will be discuss in Chapter 3. They include implantable wearables, healthcare & fitness trackers, wearable cameras, smart glasses and smart watches.

This study focuses specifically on the use of wearable devices for sustained health monitoring. The next section will further explain the different purposes of wearable devices in healthcare. The categories identified in this study include wearable devices for remote health monitoring, physical activity and weight loss, monitoring nutrition, prescription adherence, early symptoms detection of disorders, and wearable devices for monitoring stress levels.

2.4 Wearable Device for Remote Health Monitoring

Wearable devices offer remote health monitoring systems that are more efficient, cost effective, lessen the chances of developing disease, and assist in prolonging the life of overweight adults (Sarasohn-Khan, 2011). Batsis, *et al*. (2016) argued that wearable devices provide instant feedback that enables overweight adults to monitor their health activities, including weight loss. Self-monitoring of diet and physical activity helps to evaluate blood pressure in order to reduce cardiovascular disease risk and this improves the lifestyle of overweight adults (Kelli, Witbrodt & Shah, 2017). Safavi, and Shukur (2014), opined that wearable devices give caregivers the possibility of supervising obese patient's health and wellness remotely. This thereby provides advanced health monitoring without the barriers of space and time.

Wearable devices facilitate overweight adults' access to medical treatment and provide a more efficient means of monitoring and managing their health personally, taking more control of their own health-related behaviours and as well reducing the number of times they need to see their physicians (Montgomery, Chester & Kopp, 2016). Figure 2.2 shows a typical example of a remote health monitoring system supported with wearable technology that can be used to collect fitness related data through body worn wireless sensors that broadcast to the health workers and caregiver through an information gateway like a mobile phone. The information generated from this system helps health workers and caregiver to implement interventions, as needed (Patel, Park, Bonato, Chan & Rodgers, 2012).

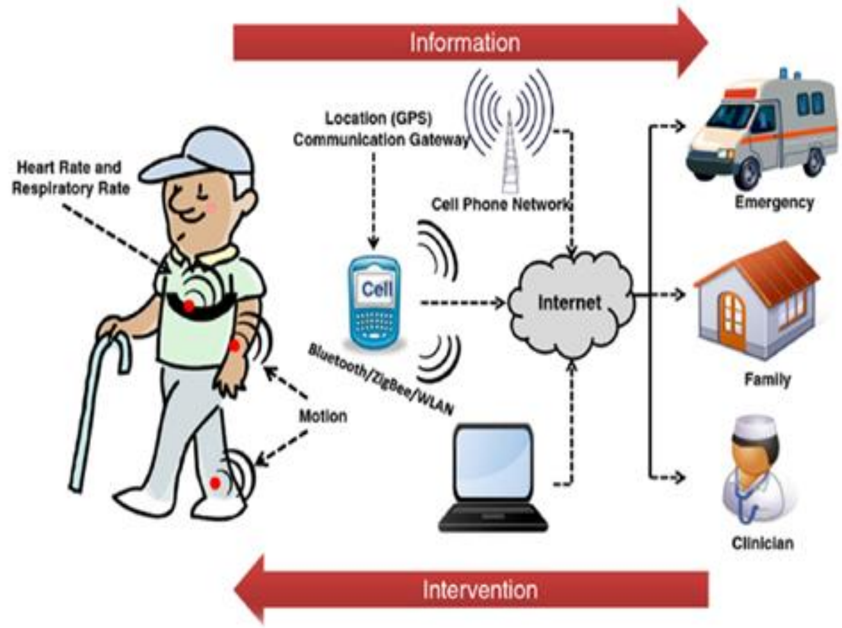


Figure 2.2: Remote Health Monitoring System (Patel *et al.*, 2012)

Remote monitoring devices, such as telemedicine and mHealth could alleviate health access matters; wearable devices are found helpful in bringing remote health care delivery to rural dwellers (Agency for Healthcare Research and Quality, 2005). The wearable devices provide data which can then be used by the doctor/s to provide more accurate diagnoses. Also, a user's exact medical needs could be easily communicated electronically to the health center to obtain a faster reply from the doctor (Accenture, 2015). Alshurafa, Pourhomayoun and Sarrafzadeh's (2016) findings indicated that wearable devices are used for health remote monitoring and communicating with patients by physicians whilst optimising the time of physicians, reducing hospital charges, and enhancing quality of care. The study of Scherr *et al.* (2009) used a wearable device and a digital scale to monitor blood pressure; the device was used to daily minor patient's blood pressure, weight, and medication dosages. Fraternali, *et al.* (2012) emphasised that wearable devices are beneficial to overweight adults as valuable tools for remotely diagnosing and treating increasing global persistent conditions of the obesity scourge. In addition, wearable devices have been found to improve the lifestyle of overweight adults as they are used remotely to calculate calorie expenditure, daily routine and activities performed such as judging, walking, trekking, going upstairs and downstairs, sitting and standing.

Huang, *et al.* (2014) studied the use of wearable devices for on-bed health monitoring. Their study revealed how the device allows health workers, physicians and caregivers to monitor patients' health remotely. Bhatia, Walker, Polk and Hande (2006) opined that a wearable device is advantageous to both the patient and physicians as it has a wireless communication system capable of remotely monitoring a patient's health without the physician being present. Stone's (2010) study revealed how wearable devices help to monitor and measure overweight adults' blood glucose, blood pressure, and weight. The study of Shaw, *et al.* (2016) opined that wearable devices have improved the quality of the lives of overweight adults with acute illnesses as the wearable devices have helped to remotely monitor fluctuations in their blood sugar, weight loss, diet, track activities and health status. They have assisted overweight adults to communicate health-related information to doctors and medical record systems remotely.

2.5 Use of Wearable Devices for Physical Activity and Weight Loss

Overweight and other types of diseases have impelled researchers' attention towards discovering an effective means to encourage physical activity and ameliorate weight gain (Coughlin, & Stewart, 2016). There are several traditional techniques and interventions but, in spite of the accomplishment of traditional interventions of weight loss, they are expensive, rigorous, and resource exhaustive (Naslund, Aschbrenner & Bartels, 2016). It requires help from health workers and instruction towards attaining patient's individualised exercise or weight loss objectives (Naslund *et al.*, 2016). In a bid to achieve cost effective and less resource exhaustive interventions in promoting physical activity among overweight adults, technologies have been deployed to promote physical activity and weight loss.

Naslund *et al.* (2016) posit that technology deployment in the health sector, such as wearable devices for activity tracking, has led to an innovative means of managing overweight adults' physical fitness and healthy lifestyle. The rising adoption of technological-based interventions for health tracking, symptoms tracking as well as managing and preventing overweight among adult is now a new trend, deployed to enhance healthy lifestyle, change behaviours related to overweight as well improvement in physical activities and diets detrimental to healthy living. Technology-based interventions are altering the way people eat, communicate and share information (Ramalho, Silva, Pinto-Bastos & Conceição, 2016).

According to PureProfile, (2015) wearable activity trackers are gaining widespread adoption and this provides an opportunity to incorporate such devices into physical activity interventions. Commercially available activity levels tracking devices allow real-time support and feedback for health behavioural change among overweight adults (Mercer, Giangregorio, Schneider, Chilana, Li, & Grindrod, 2016). Wearable activity tracking devices are scalable and help to support physical activity for weight loss among overweight adult (Naslund *et al.*, 2016). Schrager, *et al*. (2017) studied the efficiency of a wearable device for trailing physical activity during exercise behaviour and fitness. Their study revealed that there was a general improvement in physical activity among overweight adults. Lyons, Lewis, Mayrsohn and Rowland (2014) opined that wearable technology help overweight adults to set a personal goal while making it possible for the goal user to enjoy the opportunity of tracking physical activity in graphical forms.

Also, the findings of Kim (2016) revealed that wearable devices encourage adults to engage in any type of exercise. These devices are helpful to adults to keep track of their daily activities electronically in a more secure and safe way. Jakicic, *et al.* (2016) carried out a study at the University of Pittsburgh on the efficiency of wearable devices and how they improve the lifestyle of overweight adults. A total of 471 adult respondents were examined comparing regular behavioural weight loss intervention with technology-driven weight loss interventions. The result of their findings revealed that there was significant feedback on physical activity of overweight adults with wearable devices and their weight loss. Patel, Asch and Volpp (2015) stated that wearable devices offer many features that are more pleasurable, encouraging better commitment of overweight adults to be physically active.

Yellowlees (2017) also studied the use of wearable devices and physical activity of overweight adults. His study revealed that technology driven intention significantly enhanced fitness, physical activity, weight loss and the diet of overweight adults. Subsequently, Pressman (2016) carried out a study to assess efficiency of wearable devices for weight loss among Americans; this study also found that wearable devices promote weight loss. In a bid to establish efficiency of wearable devices for weight loss, an experimental intervention was carried out by Granado-Font *et al*. (2015) on overweight adults. Their findings revealed that the use of wearable devices promoted healthy lifestyle, helped to adjust dietary patterns and reduce cardio metabolic risk factors of overweight adults.

2.6 Wearable Devices for Monitoring Nutrition and Dietary Plans

To curtail the issue of managing and controlling healthy eating, ever since the mid-20th century quite a number of techniques have been explored. Conventional methods were mostly manual in nature with handwritten self-reports of nutritional ingestion among the initial conventional methods of food eating recording (Vu, Lin, Alshurafa & Xu, 2017). However, conventional monitoring depends on self-reporting, but, self-reports are liable to be under-reported on average by twenty to fifty percent (Jovanov, Sazonov & Poon, 2014). The self-monitoring invention of wearable technology is designed to improve the lifestyle and track activity of overweight adults on a daily basis to improve their level of weight loss (Cheatham, Stull, Fantigrassi & Motel, 2018).

Thus, the emergence of Information Communication Technologies (ICTs) has altered the traditional methods in which the ever-present use of wearable devices has significantly improved the health lifestyle of overweight adults; it is easier for them to monitor and manage their food intake, weight as well as dietary behaviour (Oldenburg et al., 2015). Dorman, *et al.* (2009) asserted that ever since the integration of ICTs and related technologies such as wearable devices, the healthy lifestyle behaviour of overweight adults has been enhanced, particularly their healthy intake and weight management. The study of Alshurafa, Pourhomayoun and Sarin (2015) has developed a necklace as a type of wearable device to monitor nutrition intake of overweight adults. The necklace has the ability to differentiate between liquids and solids, differential hot and cold drinks as well as differentiate between solid foods categories. This device aids patients with their management and monitoring of their eating patterns over time. Such a wearable device offers competitive and significant benefits over the more conservative means of assessing consumed energy, physical functioning and physical activity in overweight adults with chronic illness (Allet, Knols, Shirato & de Bruin, 2010). Alturki, and Gay (2016) opined that during the last few years, wearable devices' usage has increased and gained recognition in health behaviour interventions, particularly for overweight adults who desire weight loss.

The study of Jovanov, Sazonov and Poon (2014) revealed how sensors in wearable devices evaluate nutrients directly in the overweight adult's bloodstream, monitor malnutrition, indigestive activities, and eating disorders. The authors further buttressed that wearable devices facilitate real time health monitoring of overweight adults. A micro-ship detects the user's ingestion rate and afterward differentiates among the ingested foods, in spite of how small or irrelevant they may appear. It is now easier for overweight individuals to manage their health as well as efficiently attain desirable results of their daily routine through the use of wearable devices (Chung, *et al.*, 2016). Chang, *et al.*'s (2006) study revealed how wearable devices with sensors help to measure the weight and quantity of the food content and track food intake. Wearable devices improve the patients' lifestyles by assessing their nutritional intake, physical activity, and other fitness behaviours (Fox, & Duggan, 2013). Wearable devices promote healthy lifestyle behaviour, particularly healthy eating and weight management by monitoring overweight adults' food consumption style. The technology helps to deal with behaviour adjustment desired to avert obesity (Dorman et al., 2009). To this end, it has improved obese patients' ingestion and activity behaviours and help persons with obesity to become better aware of their health status (King, Glanz & Patrick, 2015). Wearable devices for eating and food-intake activity monitoring as well as food-data and record collection will be discussed in the following section.

2.6.1 Wearable device for eating and food-intake activity monitoring

Eating, physical activity and genetic composition all influence the wellbeing of adults. The amount and quality of the diet together with required energy and individuals' wellbeing are essential factors influencing physical conditioning and fitness maintenance of overweight adults (Stumbo, *et al.*, 2010). Weathers, Siemens and Kopp (2017) rightly noted that while the origins of overweight are diverse, individuals' lack of self-control when eating is consistently reported as a major contributory factor. Some overweight adults have difficulty controlling their food consumption due to the presence of high-calorie food which triggers their eating and reduces their chances of weight-loss (Redden, & Haws, 2013). Overweight adults are confronted with the problem of dealing with high calorie food consumption control and conventional means have been proven unworkable when individuals need real-time feedback about their food intake activities. To avert this situation, wearable devices emerged on the market to assist individuals' desires to control their food consumption.

For many overweight adults, maintaining a better nutritional routine could be tough, but wearable device solutions emerged as Do It Yourself (DIY) models, with the ability to monitor the patients' nutritional treatment plans, as well as calorie eating (Evans, & Matthews, 2017). Research by Kalantarian, Mortazavi, Alshurafa, Sideris, Le and Sarrafzadeh (2016) revealed that the quantity of swallows documented during a day associated with weight gain on the following day. Proper monitoring of food intake is required in order to improve and reduce the risk of obesity among overweight adults. Kalantarian *et al.*'s (2016) study carried out a comparative study of wearable devices detection of swallows. The findings from their study indicated that the accuracy of an audio-based approach was significantly higher for classifying different foods swallowed. However, this accuracy comes at the expense of computational overhead increased power dissipation due to the higher sample rates required to process audio signals compared to inertial sensor data. Many studies have used microphones for detecting food ingestion activities (Kalantarian *et al.*, 2016; Pabler, & Fischer, 2014; Sazonov *et al*., 2008). Pabler, and Fischer's (2014) study indicated how wearable devices monitor patients' chewing events with the help of chewing sounds. Kalantarian *et al.* (2016) further expressed that in the study of Sazonov *et al.* (2008) of the deployed wearable device in microphone form, the device had been positioned underneath the throat to monitor patients' eating habits. According to Farooq and Sazonov (2016), wearable devices not only helped to improve overweight adults' lifestyles by monitoring sedentary postures and physical activity, but also assisted in track energy intake and energy expenditure of overweight adults. It also helped to automatically monitor food intake in order to understand and study the issue responsible for obesity and eating disorders.

The research of Kalantarian, Alshurafa, Pourhomayoun, Sarin, Liu and Sarrafzadeh (2014) revealed the capability of wearable devices in the monitoring of food eating and categorised nutritional intake with the use of a throat microphone. In their intervention, categorisation was based on the dietary foodstuffs being consumed namely; sandwich swallows, sandwich chewing, water swallows, and none. Their study revealed how wearable devices supported healthy dietary choices of overweight adults by allowing them to monitor their eating patterns and meal times timekeeping, and by ensuring sufficient hydration levels. Weathers, Siemens and Kopp (2017) investigated how wearable devices are used to track food intake activity and how they improves the lifestyle of overweight adults. The outcome of the study indicated that wearable devices are efficient in tracking bite pieces, contrary to the old method of self-reporting. Wearable device is efficient and has improved the lifestyle of overweight adults as it permits users to effectively attain eating objectives, it lessens cognitive resource exhaustion, and does not decrease the pleasurable experience derived from eating.

The study of Chang, Liu, Chu, Hsu, Chen, Lin, Chen and Huang (2006) explained how wearable devices with sensors help to measure the weight of food content and track food intake. According to Kalantarian, Mortazavi, Pourhomayoun, Alshurafa and Sarrafzadeh, (2016), wearable devices can track eating habits, physical activity and proffer suitable aid to overweight adults through sensor signals from the patients' body sensor networks. Makeyev, Lopez-Meyer, Schuckers, Besio and Sazonov (2012) studied automated food ingestion activity recognition and their research revealed how wearable devices improved the lifestyle of overweight adults and helped them to understand their eating behaviours related to obesity and eating disorders. Kalantarian, Alshurafa and Sarrafzadeh's (2014) study revealed that wearable devices helped overweight adults to determine balance in their diets, right food intake, prompt their eating behaviour (through alerts) to maintain healthy lifestyles. Also, it helps overweight adults to sustain enough hydration levels and opportunity to monitor their historic intake patterns so as to recognize changes in diet. According to Liu, *et al.*'s (2012) study on the use of wearable devices to monitor Food-Intake, their study reported that wearable devices helped physicians to track and accurately assess nutritional intake, dietary habits of patients' in their home environment. Subsequently, Fontana, Higgins, Schuckers and Sazonov's (2014) study showed how wearable devices have enhanced healthy lifestyle of users through automatic assessment of intake activity and caloric ingestion, measurements of chews and swallows, and keeping track of food consumed.

2.6.2 Wearable Device for Food Data and Record Collection

Sun, *et al.* (2010) reported that overweight adult's nutritional self-reporting (traditional methods) are liable to inaccuracy. Wearable devices help to properly record food ingestion automatically, analyse the nutrients and calories consumed by users thereby helping to lessen the risk of overweight. Wearable devices used for patients' health monitoring provide a nonstop flow of patient physiological records as this reduces patients' hospital readmission rates (Sideris, *et al.*, 2014). Burke *et al*.'s (2005) study revealed that one of ways of improving overweight adults' lifestyles was the introduction of wearable devices that help to make data collection and analysis of self-monitoring dietary intake easier.

The study of Stumbo (2013) explained how wearable devices with a camera helped to record and monitor patients' food intake. Sun, *et al.*'s (2014) research reported how a wearable device was used for food data collection by categorising food, calculating approximately the quantity of the food and evaluating the nutrients and calories of the meal. Suh, et al. (2012) reported that wearable devices are capable of analysing and evaluating patient records, and in so doing, are boosting the quality of healthcare and averting emergency situations. Schuckers and Sazonov (2014) found that wearable device enhances tracking and keeping of food records consumed by users. Wearable device enhance precision of managing and monitoring health records, it lessen biasness and instead of depending on human, it gather data in real time (Allet, Knols, Shirato & de Bruin, 2010).

2.7 Wearable Device and Prescription Adherence

Patient medication adherence is a serious factor in the successful treatment of illnesses such as obesity, type 2 diabetes, hypertension, heart disease, stroke, depression, and in some cases, cancers. Research has shown that poor adherence to prescribed medication can impede the benefits of medical care and negatively affect evaluation of cure success (Kalantarian, Alshurafa, Nemati, Le & Sarrafzadeh 2015). Kalantarian, Alshurafa, Nemati, Le and Sarrafzadeh (2015) studied the use of wearable devices for prescription adherence. Their study revealed that the use of wearable devices is of great value to weight loss as it improves the healthiness of overweight adults' lifestyles and estimates adherence with not much patient participation. Also, Kalantarian, Motamed, Alshurafa and Sarrafzadeh's (2016) findings indicate how wearable devices enhance overweight adults' medication adherence, as the devices monitor the process of patients opening of drug container caps, the saliva swallowing and sipping of water. Krishna, Boren and Balas's (2009) study shows that there were major improvements in patients' adherence to medical treatment with the use of wearable devices.

The findings of Sideris, Alshurafa, Kalantarian, Sarrafzadeh and Eastwood (2015) explained that a wearable device has remote health monitoring system features that offer automatic messages to encourage users to adhere to the prescription routine. Wearable devices with health monitoring systems' elements are capable of optimising medical time, lessening costs of health bills, and improving excellence of healthy lifestyles and health care. The remote monitoring system element in wearable devices proffers smart electronic monitoring and forecasting of the patient's health outcome accomplishment to treatment schedule, thus teaching adults to modify their behaviour to adopt an improved lifestyle, and recognise unsafe practices (Alshurafa, Pourhomayoun & Sarrafzadeh, 2015). Kalantarian, Motamed, Alshurafa and Sarrafzadeh (2016) in their intervention, designed a wearable device for detecting users' adherence to medication. The device was effective in determining during a swallow, through the patient's skin movement in the lower part of the neck, if the medicine had been swallowed. The audio-technology is capable of detecting when the pills' containers are opened and when pills are removed from the container.

Wearable devices encourage, enhance and increase patients' levels of adherence; lessening the incidence of severe illness among adult populations (Sideris, Alshurafa, Kalantarian, Sarrafzadeh & Eastwood, 2015). Kalantarian, Alshurafa, Le and Sarrafzadeh's (2015) study indicated how wearable devices help patients to avert health complications, re-admission and or death due to non-adherence to prescribed drugs. Their research work illustrated how wearable devices help to detect patients' non-adherence to medication through piezoelectric sensors that have the ability to extract, classify and recognise activity, including that of a patient opening of a bottle (drug container) using force-sensitive resistors and including drug swallowing, using piezoelectric sensors that detect user adherence to medication. Kalantarian, Alshurafa and Sarrafzadeh (2016) found that wearable devices are capable of monitoring an adherence rate and offering higher accuracy than the traditional means, despite the lower patient burden being devoid of extensive user participation. Wearable devices with gyroscopes and built-in triaxial accelerometers, sense a number of motions which are predictors of patient medication adherence.

2.8 Wearable Device and Early Symptoms Detection of Disorders

According to Ajami, and Teimouri (2015), in the field of electronic health and wearable technology, there is an increasing concentration on the use of wearable devices with early detection of health status (disorder) with patient required medical intervention. Application of wearable devices has been proven valuable in early detection, management of severe illness and forestalling health deterioration (Patel *et al.*, 2012). Klasnja and Pratt (2012) stated that early discovery of illness symptoms is significant in the prevention of possibly severe worsening in overweight adults' wellbeing. The studies Kearney, McCann, Norrie, Taylor, Gray, McGee-Lennon, *et al.* (2009) and Holtz and Whitten (2009) revealed how patients adopted wearable devices to monitor early symptom detection. Their studies reported that the devices helped users to detect illness early. Also, Weaver, *et al.* (2007) and Kearney, *et al.* (2009) developed symptom detection systems to ease the monitoring of toxicity among cancer patients placed under chemotherapy in the United Kingdom. The devices are capable of monitor symptoms by generating reports.

2.9 Wearable Device for Monitoring Stress Levels

Lack of stress management is detrimental to the healthy living of overweight adults (Malambo, Kengne, Lambert, Villiers & Puoane, 2016). The findings of Schrager, *et al.* (2017); Linz, Taelman, Adriaensen, van der Horst and Spaepen (2007) show how wearable devices help in stress management by monitoring exercise behaviour and fitness of overweight adults. This shows how wearable devices improve overweight adults' health and lifestyle. Wearable devices proffer significant benefits over conservative techniques for attaining measures of physical activity and/or physical functioning in individuals with severe ailments (Allet, Knols, Shirato & de Bruin, 2010). The wearable tools developed by Fitbit are capable of sending warnings of stress levels to users and they recommend techniques to lessen the stress levels (Montgomery, Chester & Kopp, 2016). Also, Samsung developed a device to assess a combination of bodily processes, states and stress levels (Samsung, 2015). The devices are more precise depictions of overweight adults' health status, including stress levels and other vital information (Evans & Matthews, 2017). Wearable devices are usually used as health trackers to monitor pulse rate, muscle activity and stress levels (Al-Azwani & Aziz, 2016). They improve overweight adults' lifestyles with the use of multi-parameter physiological sensing systems to measure stress levels and evaluate crucial signs that assist in medical interventions (Pantelopoulos & Bourbakis, 2010). In the section that follows, the advantages and disadvantages of wearable devices for sustained health monitoring will be explained.

2.10 Advantages of Wearable Devices

Wearable devices have been proven to be very advantageous to overweight adults in the following ways:

- Help Overweight Adults to Avoid a Sedentary Lifestyle
- Enhance Self-Monitoring and Promote Physical and Mobility-Related Activities
- Monitoring of Health Status
- Enhance Healthy Behavioural Change
- Personalised Health Monitoring and Management
- Diseases Prevention and Early Detection and Cost Effectiveness
- Treatment Efficacy Assessment

2.10.1 Help overweight adults to avoid a sedentary lifestyle

A sedentary lifestyle is associated with an increasing number of overweight adults, experiencing wellbeing problems such as heart disease and diabetes (Knoll & Roe, 2017). The author, He (2014), posits that the length of time an individual is sedentary is associated with an increased risk of overweight, diabetes, cardiovascular disease, and all sources of mortality. Sedentary lifestyles have been reported as one of the root causes of adults gaining excess weight and can result in the development of acute diseases. Physical activity or exercise is considered to play a significant role in the management of overweight adults' health (Allet, Knols, Shirato, & Bruin, 2010). Van der Ploeg (2012) added that the quantity of time exhausted in sedentary behaviour, independent of physical activity levels among overweight adults, can be a significant health risk factor for all reasons, particularly that of death.

Tedesco, Barton, and O'Flynn (2017) state that unceasing and acute related diseases affecting overweight adults can be vetoed by raising the intensity of overweight adult's physical activity, and among the numerous devices considered for this purpose, wearable motion detectors are the only guaranteed technology allowing an automatic, nonstop and continuing evaluation of subjects in free-living environments. Allet, Knols, Shirato and Bruin (2010) concur that wearable devices help overweight adults to avoid a sedentary lifestyle, as well as lessen the risk of developing chronic diseases by engaging them in a number of physical activities daily. The use of wearable devices is advantageous over traditional systems of acquiring information about physical activity of overweight adults. They help to monitor overweight adult mobility related activities and acute diseases related to their physical activities (Allet, Knols, Shirato, & Bruin, 2010).

Wearable devices are one of the greatest means of inspiring people to become more active, as the devices have been proven to boost physical activity of overweight adults (He, 2014). They help people to lessen their inactive lifestyles and intelligently track adults' sedentary behaviours and physical activities as well as identity the time, location and activity of overweight adults (He, 2014). Godinho *et al*., (2016) see wearable devices as a cutting-edge advance in modern medicine used to obtain unbiased measurements and data about overweight adults. Wearable technologies improve the health lifestyle of old adults and the general population by increasing their energy expenditure through physical activities such as cycling, walking, and running etcetera (Knöll, & Roe, 2017). An individual that is physically active will sustain healthier body composition and weight and have fewer risk factors associated with being overweight (Washington, Banna, & Gibson, 2014). Wearable devices have been recognised as promoters of outdoor physical activity which is very essential because persons who engage in physical activity are likely to be healthy (Kaczmarek, Misiak, Behnke, Dziekan, & Guzik, 2017).

2.10.2 Enhance self-monitoring and promote physical activities

Physical activity is vital to broad wellbeing. It is vital to evaluate and monitor the physical activity of overweight adults throughout their daily life conditions because the constraint of physical activity affects their quality of life (Verlaan *et al*., 2015). A study by Nam, Kim, and Kim (2016) considers an indecorous lifestyle such as lacking exercise, overeating and assuming unevenness of body postures as the major causes of overweight among adults. Remarkably, wearable devices emerged as tools that can be deployed for augmenting the efforts of decreasing the level of overweight among adults. Wearable devices permit evaluation of the physical activity of overweight adults during daily life activities such as stair climbing, sitting, walking, standing and rising from a chair (Verlaan et al., 2015). These innovative technologies also engage overweight adults via goal-setting and reminders which enhance physical activity. It has many advantages in monitoring of heart rate, managing weight loss as well as psychological health of overweight adults (Kelli, Witbrodt & Shah, 2017). These technologies are to monitor overweight adults' physical activities, improve their longer-term weight loss (Jakicic *et al.*, 2016). Wearable devices allow overweight adults' movements to be tracked for estimating the effectiveness of exercise (Lindberg, Seo, & Laine, 2016). The various types of wearable technologies specifically designed for promoting physical activities will be discuss in Chapter 3.

Mercer *et al.* (2016) reported that wearable fitness activity trackers enhance physical activity levels of individuals that could not initially meet up with their recommended daily activity goals; with the help of wearable devices, they were able to meet up with the said goals. They helped to maintain energy equilibrium in the overweight adults' bodies which is a critical state, as excess energy accumulation is the main reason for overweight (Sharma & Padwal, 2010). Wearable devices have been helpful to overweight adults in self-monitoring and the tracking of physical activity effortlessly which is an effective approach to sustain health monitoring (Wise, Orr, Wisneski, & Hongu, 2014). Self-monitoring was usually performed with pencil and paper, but with wearable devices overweight adults can now personally monitor their health accurately, effectively and efficiently, with ease.

2.10.3 Monitoring of health status

The exponential growth in the number of the elderly population and the emergence of excess weight and chronic diseases have led to changes in the lifestyle of adults. These necessitated proper daily, regular monitoring of health status of overweight adults to avert associated complications identified in Section 2.2.2. The emergence of wearable devices is promising to boost the quality of overweight adults' lifestyles (Yilmaz, Foster, & Hao, 2010). For overweight adults to stay healthy, wearable devices have been found useful for the monitoring of treatments approach identified in Section 2.2.3. Wearable devices have been regarded as effective tools for monitoring health status of overweight adults so as to reduce energy intake and increase energy expenditure as well as reduce body weight (Rogers *et al*., 2016). This would help detect diseases and upsurge understanding of their health status and medical needs. Also, wearable device could be used by overweight adults who are being discharged from the hospital to gauge their recovery and quality of life. Additionally, information from these wearable devices could help healthcare professionals to detect associated risk factors of excess weight among users (Medical News Today, 2014). Instead of conventional checking of health status of overweight adults by health workers at every interval, wearable devices do the checking in real-time (Adventist University of Health, 2017). Wearable devices are now diagnostic tools for detecting severe depressive symptoms and the number of physical activities performed; this is done seamlessly and effortlessly and prompts appropriate reactions (Piwek *et al*., 2016).

2.10.4 Enhance healthy behavioural change

Wearable devices are helpful in facilitating behavioural adjustment among overweight adults as well as encouraging long-term healthy behavioural changes (Patel, Asch, & Volpp, 2015). Wearable devices are a significant platform for positive behavioural formation and management of stress and sleep patterns of overweight adults (Clinical Trials, 2016). Also, these devices permit users to see how target behaviours align with aims, which can be useful in influencing new behaviour (Tate, Lyons & Valle, 2015). The manufacturers of wearable devices also employ a series of digital persuasive methods to enhance user engagement, such as the gamification of activities (Piwek *et al*., 2016). Sullivan and Lachman (2017) identify self-regulatory, self-monitoring, goal setting and social support as the key benefits of wearable devices to healthy behavioural change. The benefits are prompted by a noticeable reminder from the device in order to enhance healthy behavioural objectives resulting in an enduring behavioural change (Gualtieri, Rosenbluth, & Phillips, 2016; Fox, Garland, Keibel, & Saxon, 2017). To this end, wearable devices presently provide real-time feedback and lifestyle intervention among overweight adults (Batsis *et al*., 2016).

2.10.5 Personalised health monitoring and management

Wearable devices are adopted to supply required personalised information with regards to the overweight adults' therapeutic states (Dietz *et al*., 2015). This unique style of personalised health monitoring and management has been made possible as a result of a remarkable development in wearable technologies (Serhani *et al*., 2016). Wearable devices have the potential of identifying and notifying the user of occurrences of abnormalities in the body system in order to provide the required intervention by healthcare professionals (Esposito, Minutolo, Megna, Forastiere, Magliulo, & De Pietro, 2018). This novel technological tool has made the tasks of personal health monitoring more effective, playing an active role in remotely managing users' health statuses (Joe & Demiris, 2013). Health monitoring devices such as smart wearable devices, electrocardiography (ECG), weight scale and blood pressure application are used to offer personalised health management seamlessly for patients (Esposito *et al*., 2018). Self-health management of overweight adults entails adherence to best practice recommendation such as glucose monitoring, dietary intake management, physical activity. Thus, self-health management practices through real-time reminders, continuous glucose monitoring (CGM) and wearable food intake monitoring devices increases compliance (Joe & Demiris, 2013).

2.10.6 Diseases prevention and early detection

There is a growing demand to monitor adult's health status while in their personal location and out of the hospital for early symptoms' detection and prevention (Pantelopoulos & Bourbakis 2010). To address this demand, wearable devices are designed to deliver real-time feedback information about an adult's health situation either to a healthcare provider or users of the device (Pantelopoulos & Bourbakis, 2010). The applications of health technology in early detection and preventive healthcare systems have proven very useful. The traditional hospital-cantered system was initially to diagnose and treat patients. With the advent of wearable technologies, a novel healthcare model emerged which is no longer focusing on treating the disease, but largely on early detection, diagnosis, prevention and treatment (Coelho, & Bastos-Filho, 2016).

Wearable devices monitor, detect and diagnose overweight adults with cardiovascular, neurological, and pulmonary diseases as well as other associated risk factors (Patel *et al*., 2012). They enhance prompt medical interventions as they are used for detecting early symptoms and preventing such conditions in overweight adults' health statuses (Innovatemedtec, 2017b). Wearable devices predict diseases early before they manifest, based on the amount of data retrieved from the device in order to help healthcare professionals make quick decisions about the best way to care for such patients (Schroetter, 2014; Richter, 2015). Thus, early detection of associated risk factors reduces the susceptibility of the overweight adult to acute diseases (Coelho & Bastos-Filho, 2016).

2.10.7 Treatment efficacy assessment

In recent decades, the healthcare sector has experienced advancement: individuals with acute ailment are now living longer as a result of technologies such as wearable devices. How caregivers and physicians care for overweight adults has been altered as wearable technologies help in providing quality care service. Wearable devices are widely used in day-to-day life for diagnosing as well as assessing treatment efficiency (Patel *et al*., 2012). Wearable technologies reduce the cost of health care to overweight adults, whilst also enhancing their well-being and health outcomes in many ways (Kumar *et al.*, 2013). These technologies also help overweight adults to measure functional status, the progress of physical activity by calculating pulse, steps, and quality of sleep as well as how they respond to their treatments (Clinical Trials, 2016).

2.11 Disadvantages of Wearable Devices

In spite of the benefits of wearable technologies to overweight adults, major shortcomings are identified. These shortcomings include

- **Cost of Purchasing Wearable Devices**
- **Privacy and Security Concerns**

2.11.1 Cost of purchasing wearable devices

For wearable devices to receive more acceptance among all users, they must be cost-effective. An investigation carried out by Al-Azwani and Aziz (2016) reveals that cost remains a major bottleneck to an average user of wearable devices. The study of Jessgroopman (2014) indicates that 55% of the respondents found wearable devices too costly to acquire. Presently, manufacturers are besieged with their inability to balance the cost of wearable devices with their added value to consumers. Different studies have identified costs as the major and significant impediment of wearable adoption and use among overweight adults (Casselman, Onopa, & Khansa, 2017; Nagtegaal, Verzijl, & Dervojeda, 2015; Jessgroopman, 2014). Naslund, *et al.* (2016) argue that the actual charges of the wearable devices continue to be the major hindrance that cannot be ignored among low-income individuals. Wearable devices costing an exorbitant price could be an impediment for low-income overweight adults to procure on their own.

Casselman *et al.* (2017) opined that one of the major issues impeding the successful acceptance and use of wearable devices among overweight adults remains purchase price.

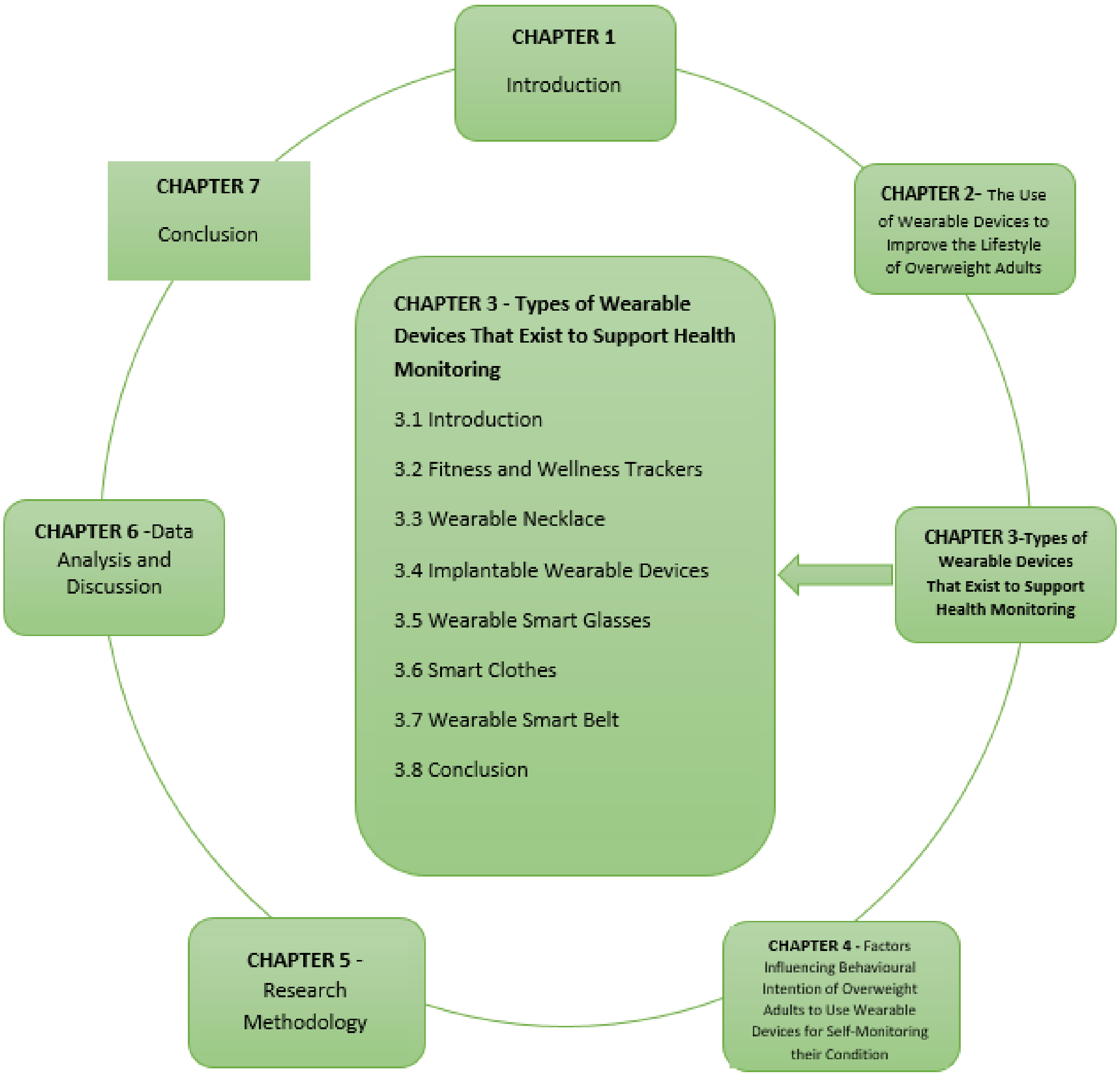
2.11.2 Privacy and security concerns

Privacy and security concerns have become more complex as platforms multiply and integrate with each other (PWC, 2014). The producers of wearable devices gather data from users and there are notions that some of these producers are willing to share users' information with third parties (Al-Azwani, & Aziz, 2016). These include behaviour, gender, profiles, age, location, social media accounts and email address as well as GPS information. Confidentiality and security of personal data produced by the users are major issues faced by users of wearable devices (Al-Azwani & Aziz, 2016). Thus, users of these devices are worried about data sharing and confidentiality of their information with the manufacturers because they do not own their data (Spann, 2016). In addition, users' personal information can be disclosed to a third party, increasing chances of identity scams (Piwek *et al.*, 2016; Gross 2016). Likewise, Fiercebiotech (2014) indicate weak privacy concerns as a major impediment hindering the continuous use of wearable devices among some individuals.

2.12 Conclusion

This chapter explained the use of wearable devices in improving the lifestyle of overweight adults. The common risk factors associated with being overweight, its complications as well as an effective approach for treating the prevalence of being overweight were discussed. The use of technology is considered an innovative solution to improve individual lifestyles and healthcare systems. The literature further highlighted the effectiveness of wearable devices for physical fitness and weight loss as it revealed general improvement in the physical activity among overweight adults who wore them. Wearable devices helped to attain the major objective of facilitating a healthy living lifestyle and changing unhealthy lifestyle behaviours of overweight adults to avert obesity. Also, a health monitoring device is efficient in improving the lifestyle of an obese patient as it permits the patient to effectively attain his/her eating objective, it lessens cognitive resource exhaustion, and does not decrease pleasure experience derived from eating. Wearable devices facilitate overweight adults' access to medical treatment and are a more efficient means to monitor and manage their health personally, by taking more control of their own health-related behaviours. Lastly, the advantages and disadvantages of wearable devices for sustained health monitoring were explained. Chapter 3, next, discusses the types of wearable devices that exist to support health monitoring.

CHAPTER 3



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Types of Wearable Devices That Exist to Support Health Monitoring

3.1 Introduction

This chapter will examine the various types of wearable technologies that exist to support health monitoring. Wearable devices are increasingly gaining significant popularity. There are various wearable devices available on the market, ranging from smart fitness and wellness trackers, clothes, glasses, belts, shoes and contact lenses. In this chapter, the researcher evaluates various wearable health monitoring devices that are presently on the market that can be used to efficiently track users' activity levels. Evenson, Goto and Furberg (2015) identified the Fitbit on the market as one of several wearable devices available that has shown potential in influencing adherence to self-tracking of activity levels in different populations. Wearable devices' technology is usually presented in the form of a bangle, wristwatch, or pendant and cloth that give feedback of users' everyday activities like a total step count, heart speed, and energy disbursement etcetera (Cheatham *et al.,* 2017). There are different types of wearable devices presently on sale in the market, but they can be categorised as fitness and wellness trackers, implantable, necklace, smart glasses, smart clothes and smart belts. The chapter will further discuss the different types of wearable devices that exist to support health monitoring. The first section will discuss the fitness and wellness trackers. The next section will explain necklaces, implantables and smart glasses available to support health monitoring. Lastly, smart clothes and smart belt wearable devices will be discussed in this chapter.

3.2 Fitness and Wellness Trackers

Wellness and fitness trackers are types of wearable devices worn by an individual to monitor their health and associated activities, send feedback to users, generally via an analogous app or mini-display on the wearable device (Allen & Christie, 2016). The popularity of fitness and wellness trackers is increasing. The rising need to manage body weight and maintain a fit lifestyle is very vital for overweight adults (de Laet, 2017). According to Callaway and Rozar (2015), many popular wearable devices designed to check overweight adult health and activity are worn either by clipping the devices onto clothing or on the wrist as a bangle. The wearable fitness and wellness tracker is capable of assisting overweight adults to attain their fitness goal as well as obtain precise information about position and movement (Kaewkannate, & Kim, 2016). Major features of these devices includes tracking of steps, calories consumed, distance and floors climbed, heart rate, sleep patterns, interactive guidance, real-time digital instruction and post-exercises breakdown of distance (Allen & Christie, 2016; Riverview Health, 2015; Swan, 2012). The device is also capable of transmitting data via the Bluetooth LE protocol and can be configured to access the Internet via Bluetooth tethering and then store the data in a database for access by caregivers (Kalantarian *et al*., 2016). These trackers have not only enhanced overweight adults' physical activity levels, but also transformed healthcare and the practice of medicine (Kelley, 2014). There are varieties of fitness and wellness trackers in the market, made by different manufacturers with different distinct unique designs and features, but serving almost the same purpose. Some of the wearable fitness and wellness trackers include Fitbit, Jawbone, Nike+ FuelBand, Garmin, Polar, Samsung Gear Fit and Apple (PWC, 2016; Berg Insight, 2014). The subsequent section explains typical examples of fitness and wellness trackers.

3.2.1 Fitbit

Fitbit has been identified as one of several wearable devices available in the market that has shown potential in influencing self-tracking of activity levels (Evenson *et al*., 2015). Fitbit is a wristband activity tracker that automatically detects quality of sleep, number of steps taken and monitors heart rate via an accelerometer (Fitbit, 2017). Fitbit users can connect their device to a mobile phone via Bluetooth as well as upload their daily activities into the Fitbit online dashboard. Filipowicz, and Mcgraw (2017) explain varieties of health and wellness product offers by Fitbit such as Zip, One, Flex2, Atla, Charge2, Blaze and Surge activity trackers that are available in their market. Figure 3.1 depicts different types of Fitbit activity trackers. Schrager et al. (2017) used Fitbit to assess the effectiveness of exercise practices among emergency medicine residents. Their findings revealed overall changes in the amount of physical activity among the medicine residents that used Fitbit.

Figure 3.1: Fitbit Activity Trackers (Fitbit, 2017).

3.2.2 Jawbone

Jawbone is the manufacturer of wearable devices that mostly focus on fitness trackers powered by data science (Jawbone, 2017). Jawbone offers four different kinds of fitness trackers that synchronise wirelessly via Bluetooth such as UP2, UP3, UP4 and UPmove. Figure 3.2 shows some of the types of Jawbone activity trackers. The device provides users with a personalised insight on their eating patterns, sleeping patterns, calories burned, distance travelled and heart health monitoring via their UP system (Kaewkannate, & Kim, 2016). Also, users of Jawbone have access to smart coach systems, a unique guide that motivates and learns about user's habits.

Figure 3.2: Jawbone Activity Trackers (Jawbone, 2017).

3.2.3 Nike + FuelBand

Nike+ Fuel is a three-dimensional fitness tracker mostly worn on a non-dominant arm to inspire users to monitor their activity levels (Kooiman, Dontje, Sprenger, Krijnen, van der Schans, & de Groot, 2015). Nike+ Fuel tracks users' body movements and performance, calories burned, steps taken, personal goals, thereby helping users to train better, as well as share their goals' achievement among friends. Also, the wearable tracker gives out rewards to the users in the form of fuel points based on steps taken and exercise duration (Nike, 2017). Tucker, Bhammar, Sawyer, Buman, and Gaesser (2015) studied the validity and reliability of Nike+ for estimating physical activity energy expenditure among young adults. The study outcome indicated that Nike+ allows young adults to correctly monitor their activity levels as well as accurately track energy expenditure. See Figure 3.3 for some of the types of Nike + FuelBand activity trackers available in the Nike market.

Figure 3.3: Nike + FuelBand Activity Trackers (Nike, 2017)

3.2.4 Garmin

Garmin is one of the top growing manufacturers of activity trackers and smart watches. The wearable devices help users track their daily activities, calories burned, steps, distance as well heart rate via IQ auto-detection software (Thubron 2016). The activity tracker uses a global positioning system with an inbuilt optical sensor to measure users' heart rates through Mio heart rate technology (Dooley, 2016). Figure 3.4 shows some of the wearable devices produced by Garmin including Vivoactive, Vivomoves HR, Vivofit Jnr, Vivosport, Fenix, Forerunner, Vivosmart and Vivofit (Garmin, 2017).

Figure 3.4: Garmin Activity Trackers (Garmin, 2017)

3.2.5 Polar

Polar is one of the top producers of wrist activity trackers in the wearable technology industry. It is the first company that produced wrist activity trackers with heart rate monitoring devices. Polar provides a complete weight management service, monitors calorie consumption, daily activity level, heart rate via an acceleration devices motivating users towards an improved health status (Polar, 2017). Polar offers various categories of activity trackers ranging from lifestyle, sport, pro as well as application and compatible sensors. Figure 3.5 depicts different types of Polar activity trackers. Some of the examples of these products are Loop Crystal, Loop 2, Loop, Balance, A370, A360, A300, M400, M600, M450, V630, V800, and the H10 heart rate sensor (Polar, 2017).

Figure 3.5: Polar Activity Trackers (Polar, 2017)

3.2.6 Samsung gear

Samsung gear is also considered to be one of the dominant activity trackers worn on the wrist. The activity tracker gives an update on daily calories consumed, measures heart rate as well as health and diet goals from a user's wrist (Samsung, 2017). What makes Samsung gear unique in comparison to other activity trackers is that it has a built-in music player and camera without it being connected to a smartphone. Some of the smart fitness bands manufactured by Samsung include Gear S2, Gear S3, Gear Fit 2, Gear Fit Pro as well as Gear Sport (Samsung, 2017). Typical examples of Samsung Gear are shown in Figure 3.6.

Figure 3.6: Samsung Gear Activity Trackers (Samsung, 2017)

3.2.7 Apple watch

The Apple watch is one of the major competitors in the wearable technology industry. Apple Watch uses associated workout applications to continuously measure standing time, calories burned, activity minutes and distance travelled. The watch also uses photoplethysmography (PPG) to measure heart rate through green infrared light-emitting diodes (LED) (Apple, 2017). The heart rate measurement through PPG is an optical technique that can automatically detect the volume of blood flowing through a user's wrist at any given moment (Allen, 2007). The Apple activity trackers come in different styles such as Series 3, Hermes, Edition and Series 1 (Apple, 2017). Figure 3.7 shows some of the wearable devices produced by Apple Incorporated.

Figure 3.7: Apple Watch Activity Trackers (Apple, 2017)

3.3 Wearable Necklace

The Piezoelectric necklace is a wearable device for measuring medication ingestion and monitoring of nutrition. This wearable necklace is often used to improve patients' adherence rate and other negative effects due to patients' non-adherence to prescribed pills (Kalantarian, Motamed, Alshurafa & Sarrafzadeh, 2016). It is a wearable nutrition and food-intake monitoring device with an implanted piezoelectric sensor, small Arduino-compatible microcontroller, Bluetooth LE transceiver, and Lithium-Polymer battery. Figure 3.8 illustrates the wearable necklace for monitoring ingestion habits and medication monitoring. It monitors via movement in the throat and skin, records and transmits to a mobile application for processing and patient assistance. Kalantarian *et al*. (2016) developed and experimented with a smart necklace for detecting medication and food intake, based on the skin movement in the lower part of the neck. The findings of their experiment and evaluation prove the effectiveness of the piezoelectric necklace for identifying medication and food ingestion. The benefit of a wearable necklace is that it amplifies sensor stability, as the neckband checks and prevents undue tangential movement that can introduce errors in ingestion recognition (Vu, Lin, Alshurafa & Xu, 2017; Kalantarian *et al*., 2015).

Figure 3.8: Wearable Necklace for Monitoring Ingestion Habits and Medication Monitoring (Kalantarian *et al*., 2016).

3.4 Implantable Wearable Devices

The deployment of implantable wearable devices is essential in supporting health monitoring activities seamlessly (Andreu-Perez, Leff, Ip, & Yang, 2015). Implantable wearable devices are designed to prevent diseases, improve overweight adults' health as well as reducing associated risk factors of excess weight gain (Khosravi, 2015). This innovative technology has a huge potential to provide an additional convenient substitute for the prevalence of other intrusive methods such as medication and surgery to deal with overweight (Daniel, 2015). Implantable wearable devices, as shown in Figure 3.9, can be injected into the human body in the form of capsule sized circuits and connected to users' smartphones for sustained health monitoring. To this end, these devices are designed to communicate between users and healthcare professionals based on data retrieved from the implanted sensors (Andreu-Perez *et al*., 2015). Such a device can be inserted into the body in various ways such as tattoos, defibrillators and pacemakers are done (42Gears Team, 2015). Implantable devices are also used for monitoring of serious heart conditions, cancer detection as well as birth-control (42Gears Team, 2015).

Figure 3.9: Implantable Wearables (Daniel, 2015)

3.5 Wearable Smart Glasses

Smart glasses are gradually becoming an integral part of the healthcare industry for detecting food ingestion and physical activity automatically, as well as the different aspects of patient care (Wrzesinska, 2015). The device consists of a piezoelectric strain sensor positioned on the temporalis muscle, an accelerometer and a data acquisition module connected to the temple of eyeglasses (Farooq, & Sazonov, 2016). A typical example of automatic glasses food intake detection and physical activity recognition are Glassense and Google Glass.

Glassense originated from Italy. It is a type of 3D-printed wearable device smart glass designed to monitor food eating patterns and facial movement (Chung, Chung, Oh, Yoo, Lee, & Bang, 2017). Two ball-typed load units are implanted in hinges on equal parts of glasses as shown in figure 3.10. Also, the obtained force signals are broadcast to a monitoring unit to sense temporalis muscle motion during eating periods and other actions, such as usual head movement (Chung *et al.*, 2017).

Google launched its smart glasses in 2013. Google Glass is a hands-free smart wearable device designed to work with medical and biomedical applications. The smart glass is embedded with a camera capable of monitoring physical and physiological movements of the users (Aungst & Lewis, 2015). It also has an application aid for social communications with autistic children: this aid recognises discussion in a timely manner and gives the user appropriate replies in return (Kinsella, Chow & Kushki, 2017). A study conducted by Wu, Dameff and Tully (2014) used Google Glass to evaluate whether medical workers at various levels could use the smart glass to carry out an ultrasound-guided procedure. The outcome of their study indicated that it was possible to carry out ultrasound-guided procedures with Google Glass. Also, less head movements were noted during procedures with Google Glass technology. Regardless of Google Glass benefits, the product was discontinued from further production due to security and privacy regulations of data, limitation in the quality of image, short battery life, and legal actions (Martinez-Millana, Bayo-Monton, Lizondo, Fernandez-Llatas, & Traver, 2016; Lewis, & Vohra 2014; Glauser, 2013).

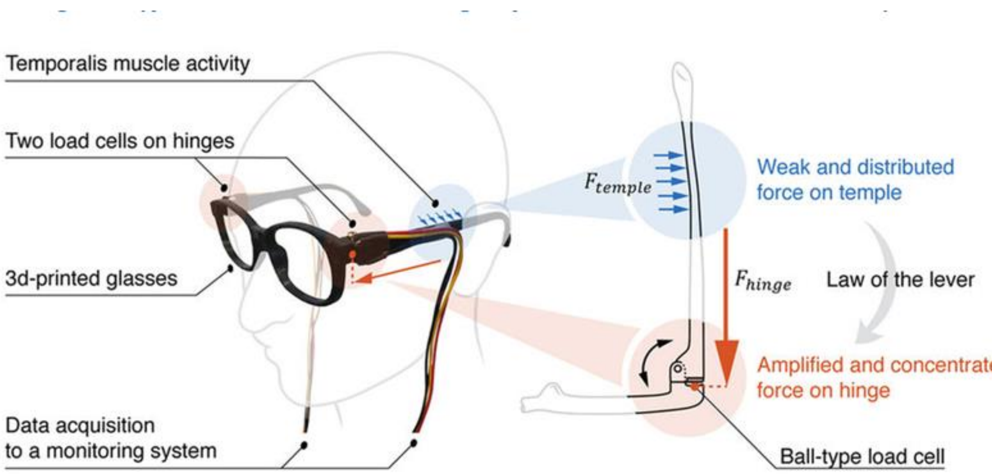


Figure 3.10: Wearable Smart Glasses (Chung *et al.*, 2017)

3.6 Smart Clothes

Health monitoring devices and their integration into wearable smart clothing have emerged as eHealth solutions, efficient in taking advantage of the improvement in communication, sensing and analysis (Standoli, Guarneri, Perego, Mazzola, Mazzola & Andreoni, 2016). Smart clothes are designed for non-stop remote monitoring of physiological movement information of the wearers (Patel *et al*., 2012)**.** It comprises textile with an implanted sensor for recording ECG data with diverse electrode designs as well as electromyography (EMG) data. Other sensors record thoracic movement, measure body temperature and abdominal signals related to respiration and movement data linked to stretching of the garment with shoulder activities (Patel *et al*., 2012)**.** Smart vest for posture monitoring comprises sensor positions (spotted lines show the sensors at the rear of the vest). The sensors implanted at different spots on the vest provide various kinds of information concerning the user's body as depicted in Figure 3.11. The device is capable of providing information on the bending of the neck and upper back, upper-trunk positions; lying, sitting, standing, leaning onward as walking, and level of shaft twisting (Lin, Chou, Tsai, Lin & Lee, 2016).

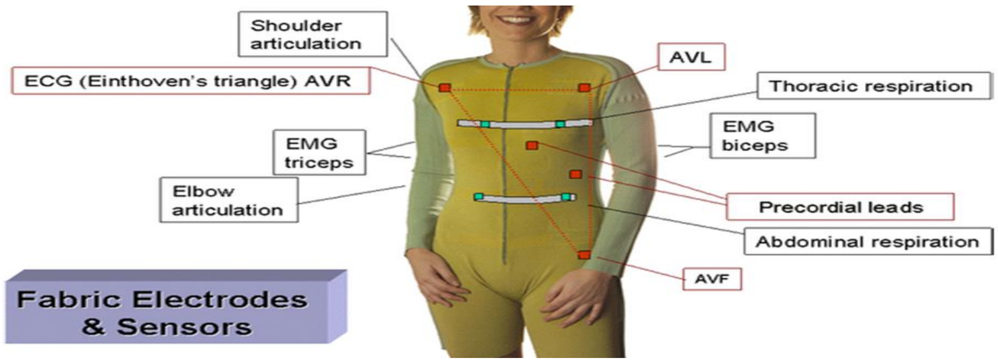


Figure 3.11: E-Textile for Remote Monitoring of Physiological Reactions and Movement (Patel *et al*., 2012)

3.7 Wearable Smart Belt

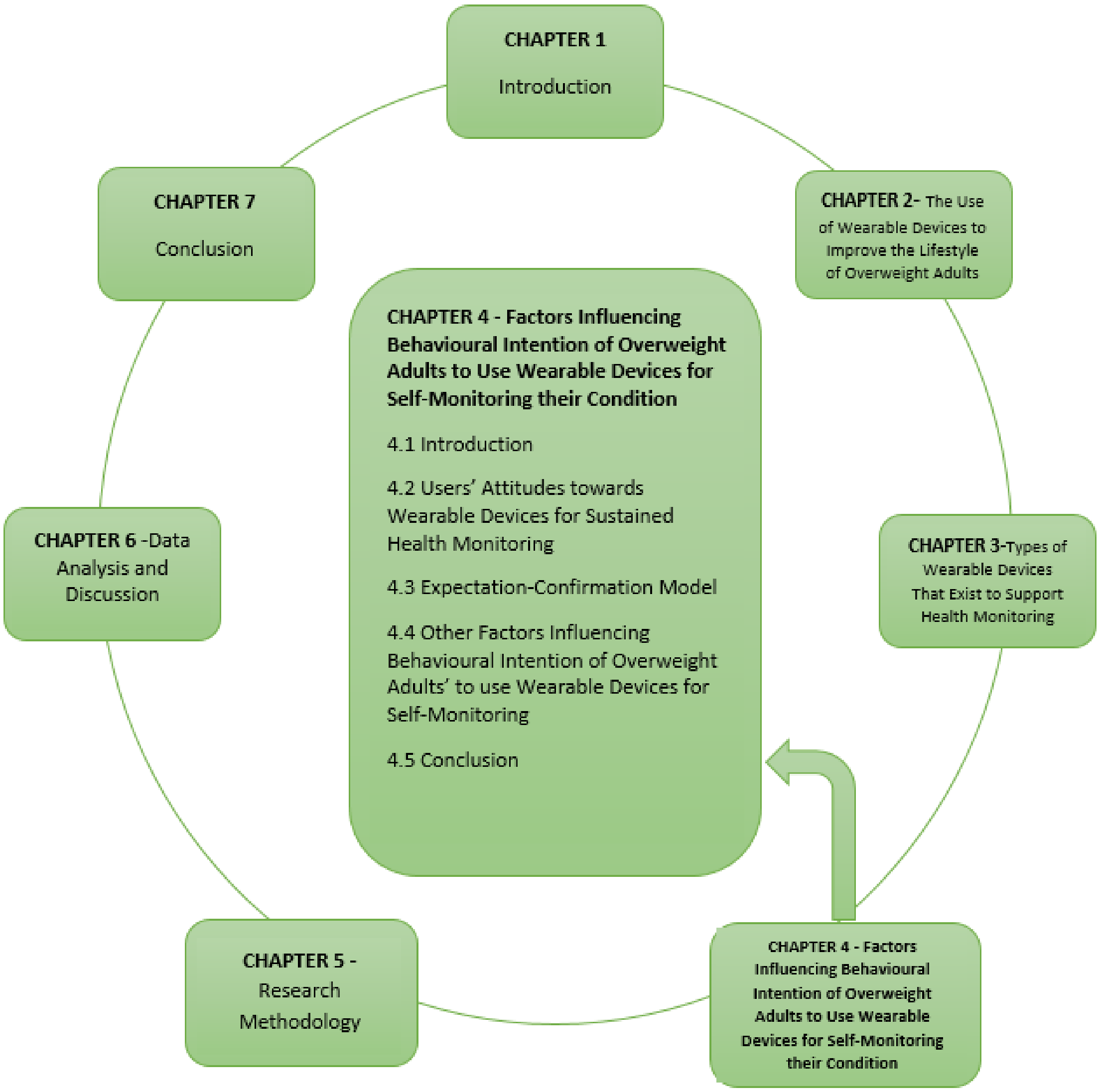
Wearable smart belt devices are designed for remote monitoring of the physiological and behavioural status of overweight adults. These devices are designed to manage and provide vital information to overweight adults and healthcare workers. This device offers individualised wireless health monitoring and a nonstop vital symptoms' analysis, such as heart speed, electrocardiogram, respiration velocity, body motion and skin temperature (Sardini, & Serpelloni, 2010). The device was designed to aid patient's health care services, monitor and assesses users' conditions as well as enhance medical understanding. As shown in Figure 3.12, the device is made up of a wearable monitoring device and Android app designed to gather information about the health status of users through the physiological sensor data (Banos, Villalonga, Damas, Gloesekoetter, Pomares & Rojas, 2014).

Figure 3.12: Wearable Smart Belt for Remote Monitoring of Physiological and Behavioural Status (Banos *et al.*, 2014)

3.8 Conclusion

This chapter reviewed literature related to the various types of wearable technologies that exist to support health monitoring. It was found that wearable devices technology is usually presented in the form of a bangle, wristwatch, or pendant and clothes that give feedback of users' everyday activities. Although, different types of wearable devices presently exist on the market, they were categorised into fitness and wellness trackers, implantable, necklace, smart glasses, smart clothes and smart belts. Thereafter, different types of fitness and wellness trackers were discussed. The fitness and wellness trackers included Fitbit, Jawbone, Nike+ FuelBand, Garmin, Polar, Samsung Gear Fit and Apple. The fitness and wellness trackers discussed were all capable of assisting overweight adults to attain their fitness goal as well as obtaining precise information about position and movement. Lastly, other wearable devices available to support health monitoring, such as necklace, implantable, smart glasses, smart clothes and smart wearable devices, were also explained. Thus, the next chapter will identify and explain factors influencing the behavioural intention of overweight adults' to use wearable devices for self-monitoring.

CHAPTER 4


CHAPTER 1
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Factors Influencing Behavioural Intention of Overweight Adults to Use Wearable Devices for Self-Monitoring their Condition

4.1 Introduction

The previous chapter examined the various types of wearable technologies that exist to support health monitoring. Accordingly, this chapter identifies factors influencing the behavioural intention of overweight adults to use wearable devices for self-monitoring. The factors are satisfaction, perceived usefulness, confirmation, Information System (IS) Continuance Intention, perceived aesthetic designs and privacy and security. Chung, Chun and Choi (2016) opined that continuous intentions greatly hinge on the previous satisfaction gained, whereas satisfaction is gained from the expectation for wearable devices to perform as envisaged. Perceived usefulness has been considered as the degree to which overweight adults believe that using wearable devices will improve their wellbeing.

The behavioural intention of overweight adults rest heavily on post adoption beliefs or experience. These factors **are mediator constructs that function as descriptive variables for understanding the direct effect of behavioural intention of overweight adults' to use wearable devices to self-monitor their condition**. On the foundation of a post adoption experience, the early overweight adult's expectation might determine whether they continue using the wearable devices for health monitoring or not. For instance, if no satisfaction is derived, the intention to continue will be altered. Also if the device constitutes a privacy threat, or the overweight adult observes that data gathered through the use of wearable devices are not secured, he/she might be less inclined to continue using the device. The behavioural intention therefore will be affected (Chen, Liu & Lin, 2013). Thus, the first section of this chapter examines the user's attitude towards wearable devices for sustained health monitoring. The second section of it explains the expectation-confirmation model (ECM) in relation to wearable devices. Thereafter, the components of the ECM will be discussed. Lastly, other factors influencing the behavioural intention of overweight adults to use wearable devices for self-monitoring, such as, perceived aesthetic designs, privacy and security will be addressed.

4.2 Users' Attitudes towards Wearable Devices for Sustained Health Monitoring

To recognise how to facilitate behavioural intention among overweight adults around wearable devices, information is required about overweight adults' attitudes and usage of such technologies (Fausset, et al. 2013). An understanding of the overweight adult's attitudes towards a wearable device is relevant in the area of usage and continuous intentions. Attitude is the main factor influencing overweight adults' intentions to use wearable devices (Hsiao & Chen, 2018). Overweight adults' attitudes could be positive or negative, according Mitzner, Boron, Fausset, Adams, Charness, Czaja, Dijkstra, Fisk, Rogers and Sharit (2010). Positive attitudes are most often linked to how the technology supports overweight adults' activities, improves their wellbeing as well as contains useful features of these devices. Mitzner *et al.* (2010) posited that the negative attitudes most often linked to wearable devices were their ability to create inconveniences, contrary features, as well as raising the given safety and dependability concerns.

Studies have shown that either positive or negative attitudes are influenced by experience and perceived ease of use (Yildirim, & Ali-Eldin, 2018; Preusse, Mitzner, Fausset & Rogers, 2016; Hamari & Koivisto, 2015). Yildirim and Ali-Eldin (2018) note that the intention of overweight adults can be predicted by their attitudes and whether they continue or stop using these devices: these attitudes are said to be generally influenced by their perceived ease of use. That is why Hamari and Koivisto (2015) assert that overweight adults' continuous intention to use wearable device is determined by their attitude towards the use of the technology. Also, Peek, Luijkx, Rijnaard, Nieboer, van der Voort, Aarts, van Hoof, Vrijhoef and Wouters (2016) affirm that interest, perceived usefulness and willingness to try out new devices are major attitudes towards technologies that can enhance lives. Chuah, Rauschnabel, Krey, Nguyen, Ramayah, and Lade, (2016) reported that there was a significant relationship between perceived ease of use and attitude, as attitudes are being controlled by perceived usefulness which, in turn, influenced behavioural intention. Likewise, Heinz, Martin, Margrett, Yearns, Franke, Yang and Chang (2013) revealed that many older adults have shown positive attitudes and interest in devices that will influence their sustained health monitoring.

Furthermore, design aesthetics and perceived value are factors discovered to have a strong direct effect on the attitude towards the use of wearable devices for sustained health monitoring (Hsiao,

& Chen, 2018; Choi, & Kim, 2016). Yang, Yu, Zo and Choi (2016) posited that previous studies have also indicated that perceived ease of use will influence users' attitudes toward using wearable devices. If overweight adults have a positive attitude toward the technology, there is a good possibility that they will use it for sustained health monitoring (Park, Leen & Kim, 2011). Spil, Sunyaev, Thiebes and Baalen (2017) explained that the attitudes towards behavioural intention to use are perceived more uncertainly, but still relatively positive. Hamari and Koivisto (2015), in their study on attitude towards wearable devices usage, revealed that the majority of users displayed positive attitudes towards these devices. They concluded that users' attitudes are the main essential factor in the usage of wearable devices for continuous daily physical activities. The study conducted by Wen, Zhang and Lei (2017) on perceived attitudes toward wearable devices revealed that just about half of the respondents were reluctant to continuously use the device due to their perceived ease of use. While, Mishra (2015) affirmed that the majority of respondents showed a positive attitude towards the use of wearable devices.

Conci, Pianesi and Zancanaro (2010) reported that despite the wearable technology being considered helpful as against the traditional means activity tracking, the attitudes towards the usage of them were negative. Also, Fausset *et al.*'s (2013) study revealed that older adult's first attitudes were positive, but after using the technology for two weeks, attitudes of the majority of older adults were negative. In the same vein, research conducted by Burton (2016) investigated the attitudes of older adults towards the wearable devices. Findings from his study indicated that the majority of the respondents exhibited negative attitudes and they would not continue using the device because it did not provide personal benefits and neither did it improve their wellbeing.

The above review showed the effects of attitude on the use of wearable devices. The review on the relationship between attitude and wearable devices is important because attitude determines behaviour. It should be noted that the behavioural intention among the overweight adults to continue using wearable devices for sustained health monitoring is determined by the knowledge that the users have about the devices (cognitive component) which would not influence the attitude (affective component) that the users would have about wearable devices. In other words, knowledge of the overweight adult to continue using wearable devices is determined by the attitude they have to the devices, and the attitude they have towards the devices would now influence their behavioural intention to continue using the devices for sustained health monitoring.

4.3 Expectation-Confirmation Model

The ECM has been widely used to examine continuance intention. The ECM originated from two different theories and one model, namely; expectation-confirmation theory, the theory of planned behaviour and the Technology Acceptance Model. These theories concentrate **on *the users' motivations in embracing a novel technology***, rather than continual usage of that technology (wearable devices) (Warkentin, 2016). These theories provide different explanations of users' acceptance behaviours, but none of these theories could clarify the rationale behind users' acceptance-discontinuance or why user discontinues the use of a particular IS after the initial adoption. Concentrating on the post-consumption phase, Bhattacherjee (2001) propounded the ECM to expound how perceptive beliefs and influences formed by consumers' own experiences can affect their continuance intentions (Leung & Chen, 2017). The ECM concentrates on three major factors; perceived usefulness, satisfaction and expectation confirmation, influencing continued usage intention (Warkentin, 2016). Adopting the ECM in this study will influence the behavioural intention of overweight adults to use wearable devices. The ECM postulates that the feelings of satisfaction after wearable device usage by overweight adults are as a result of confirmation of high perceived usefulness, resulting in increased continuance intentions. The ECM is a model that concentrates on users' behavioural intentions. It submits that the first use of a wearable device will not routinely end in continued use, so the initial use has a major role to play in determining the success of a wearable device (Bhattacherjee, 2001).

The ECM is helpful in studying and identifying continuance usage of information systems (IS) that cannot be explained by adoption models (Thong, Hong & Tam, 2006). The ECM has been found to be a strong model for illuminating behavioural intention of continuance usage of IS. The model employs four predictors, namely, perceive usefulness, confirmation, satisfaction and continuance intention (Yuan, Liu, Yao & Liu, 2014) as shown in Figure 4.1. Leung and Chen (2017) opined that the ECM was adopted by different researchers to study consumers needs at the several IS use environments to forecast users' continuance behaviours. Numerous researchers have used ECM to study users' behaviour such as perceived usefulness, expectation confirmation, continuance intention and satisfaction in business intelligence as well as post-adoption behaviour (Hou, 2015; Lai, & Cui, 2014; Sharmin, 2012). Also Chen, Huang, Hsu, Tseng and Lee (2010); Chiu, Chang, Cheng and Fang (2009); Devaraj, Fan and Kohli (2002); Bhattacherjee (2001a); Voss, Parasuraman and Grewal (1998) used the model to understand user satisfaction and continuance intention of use of e-commerce. Pereira, Ramos, Gouvêa and Costa (2015); Biasutti (2011); Chen (2011); Cheung and Lee (2011); Duque, and Weeks (2010); Hung, and Cho (2008); Chiu, Hsu, Sun, Lin and Sun (2005); Bolliger, and Martindale, (2004) used ECM to understand user satisfaction and continuance intention of use of e-learning environment and e-learning service.

The ECM is an advanced model and has been extensively used to examine behaviour in the areas medicine, e-Health, Mobile-Health adoption and lifestyle improvements and information activities (Leung, & Chen, 2017; Lai *et al.*, 2014; Brown, Venkatesh, & Goyal, 2010). This model has gained acceptance in explaining user satisfaction and IS continuance intention of use (Patricks, Libaque-saenz, Fan, & Chang, 2016; Harasis, & Rasli, 2016; Warkentin, 2016; Crupi, & Tentori, 2014; Schurz, 2014; Kim, 2010; Kim, & Han, 2009a; Kim, & Han, 2009b; Kim, Choi, & Han, 2009; Lam, Shankar, & Erramilli, 2004; Bhattacherjee, & Premkumar, 2004; Thong *et al.*, 2006; Bhattacherjee, 2001b; & Mathieson, 1991).

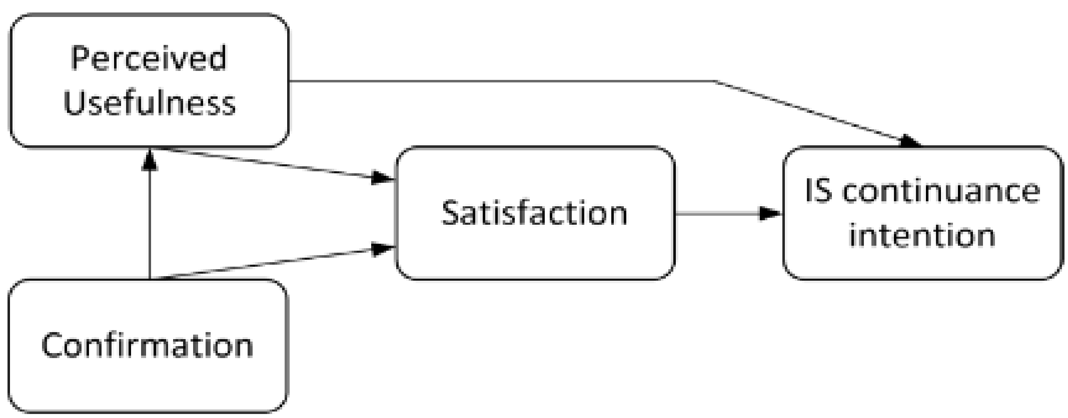


Figure 4.1: The Expectation-Confirmation Model (Bhattacherjee, 2001b)

The ECM originates from the expectation-disconfirmation model found in the marketing field. The expectations-disconfirmation model claims that users' expectations, joined with perceived performance, result in post-purchase satisfaction (Lin, 2008). According to Patricks *et al.* (2016), the ECM is fashioned on three concepts: firstly, the consequences of pre-acceptance constructs which are already catered for by confirmation and satisfaction constructs; secondly, since IS usage expectation often varies over a period of time, the ECM evaluates post-adoption expectation and not pre-adoption expectation; then thirdly, the expectation is demonstrated by perceived usefulness in the model (Patricks *et al.*, 2016). The next section discusses the major factors determining continuance behaviours.

In summary, the following factors were found to be important in the context of this study:

- Satisfaction
- Perceived Usefulness
- IS Continuance Intention
- Perceived Aesthetic Designs
- Privacy and Security

4.3.1 Satisfaction

The ECM formed the basic framework for assessing the relationship between overall user satisfaction and post-purchase behaviours (Wang, Zhao, Sun, Zheng, & Qu 2016). In this study, satisfaction denotes an overweight adult's positive or negative sentiment about the wearable devices. It can also be seen as the fulfillment of users' desires as a result of an application of wearable devices for their wellness and lifestyle. This means that satisfaction is based on the user's experience or contact with the product (Sharmin, 2012). Satisfaction is a personal judgment that is significantly influenced by individual expectations. Satisfaction or dissatisfaction results from the confirmation of user expectations concerning a product (Lee, Park, Kwon, & Pobil, 2015). The work of Lee, *et al*., (2015) indicated that behavioural intention to use IS products is determined by satisfaction.

Patricks *et al*., (2016) considered user satisfaction as the expressive behaviour towards a certain IS product by an end user; thus resulting in increased IS usage. According to the ECM, overweight adults' IS continuance intention is defined mainly by their satisfaction with the previous usage of the product. Thus, satisfied users are more motivated to continue with current IS products and if users are not satisfied or if their expectations are not met, they are more influenced to change or discontinue the usage of the product. User satisfaction is the main precursor to the continued use of the particular IS product (Lai *et al.*, 2014). User satisfaction leads to recurrence purchase, brand loyalty, and positive word of mouth. Product quality that is delivered can meet or surpass user's expectations which are mostly influenced by previous expectations (Angelova, & Zekiri, 2011). Chung, Chun, and Choi (2016) confirmed that users' repurchase intentions are highly reliant on the earlier satisfaction of the product, whereas satisfaction is achieved from the expectation for products.

Lai *et al.* (2014) postulated that the disappointment and inability of a product to meet a user's pre-adoption expectations could result in psychological discomposure. Thus, satisfied users could develop a repurchase intention whereas dissatisfied users would cease the subsequent usage of the product (Chung *et al*., 2016). Users' satisfaction and behavioural intention to continue using a product are not only affected by their previous experience, but also influenced by perceived usefulness and perceived ease of use. Both factors are usually used and confirmed to be the antecedents for behavioural intention in the ECM study (Mardiana, Tjakraatmadja, & Aprianingsih, 2015). Different researchers have indicated that satisfaction is a critical factor that can promote IS products continuance intention (Chung *et al*., 2016; Lee, *et al*., 2015). The next section explains perceived usefulness.

4.3.2 Perceived usefulness

Perceived usefulness refers to the degree of performance features to which a wearable device can be used by overweight adults to attain health objectives with efficiency, proficiency and satisfaction (Patricks *et al*., 2016). Perceived usefulness has been identified in literature as one of the strongest factors of user technology acceptance and usage behaviour of IS. Perceived usefulness is considered as the perceived probability that a wearable device will enhance overweight adults' attainment of goals concomitant with the usage of such devices. It is predicted that overweight adults have a particular objective in mind before embarking on the usage of wearable devices (Pfeiffer, Entress-Fürsteneck, Urbach, & Buchwald, 2016). These objectives include fitness tracking, monitoring of daily dietary intake, daily activities and weight loss as identified in Chapter 2 of this study. Perceived usefulness is an essential factor influencing users' post-adoption decisions, in this phase, users are expected to re-examine their initial acceptance decisions and make their decisions about continued usage (Liao, Chen, & Yen, 2007).

Pfeiffer *et al*. (2016) and Hamid, Razak, Bakar, and Abdullah, (2016) postulated that perceived usefulness is a relevant factor in forecasting usage intention and it is anticipated that it will define overweight adults' behaviour towards using the wearable devices in their efforts to improve their health status. The functionality of the wearable devices and its capability for health fitness tracking, data collection, and providing feedback about users' activity levels may likely make overweight adults perceive it as being very useful. Chuah, *et al*. (2016) reported that perceived usefulness has a strong influence on the attitude of overweight adults toward using wearable devices. Perceived usefulness stimulates overweight adults' formation of the continuance and discontinuance intention usage of wearable devices (Buchwald, Letner, Urbach, Entreß-fürsteneck, & Urbach, 2015). Individuals' intention to use, and intention to repurchase wearable devices are determined by perceived usefulness (He, Kim, & Gong, 2017). For example, information gathered by a self-tracking device can effectively contribute to overweight adults' sustained health monitoring, which might lead to a significant influence on continuance intention. Perceived usefulness is a decisive variable of behavioural intention to use wearable devices continuously (He *et al*., 2017). According to Gallant, Cynthia and Kreps (2006), perceived usefulness is the main reason that makes users decide to use and accept new IS products. The next section discusses the confirmation factor.

4.3.3 Confirmation

Confirmation of expectations is a cognitive assessment concept that was coined from the cognitive dissonance model (Zhou, 2017). Lai, Chen and Chang (2016) opined that confirmation is the degree to which user's initial expectation is confirmed by the usage of IS products. Positive or negative expectations have been recognised as one of the main factors contributing toward IS continued usage among overweight adult users (Schwarz *et al*., 2016; Patricks *et al.*, 2016). Yaojun and Yongliang (2015) confirmed that users' degree of confirmation is significantly related to the user's prior usage of IS. Users' extent of confirmation is the strongest predictor of satisfaction. Also, users' magnitude of confirmation is significantly linked with the post-usage usefulness of IS. Findings from Lai *et al*.'s (2016) study revealed that confirmation is the substantial variable driving satisfaction and IS continuance intention. The study of Susanto Chang and Ha (2016) identified that users' confirmation after the original use of IS has a positive influence on user satisfaction and, in turn, motivates users' continuance intention. Thus, satisfaction is projected mainly by confirmation.

Hu and Zhang (2016) and McKinney, Yoon and Zahedi (2002) stated that confirmation of information and system quality of IS products result in user satisfaction. User's expectation confirmation represents the real performance meeting the users' expectations (Bhattacherjee, 2001a). Jiang and Klein (2009) affirmed that if a product meets expectations, it will lead to satisfaction and if a product falls short of expectations, it will lead to disconfirmation, and the user may likely be dissatisfied. Jafari, Angali and Mohamadian (2017) reported that the most powerful reason for perceived enjoyment is confirmation and the most influential factor of usefulness is also confirmation. Thus, confirmation has a lasting influence on the behavioural intentions of overweight adults to use wearable devices for self-monitoring. The next section explains IS continuance intention.

4.3.4 IS continuance intention

Kim, Chan and Chan (2007) considered continuance behaviour of IS as continuous usage of IS by adopters, where a continuance decision follows a previous acceptance decision. Continuous intentions are a sturdy determinant of future behaviour and have been adopted as a dependent variable by several previous IS post-adoption studies (Zhao, Stylianou & Zheng, 2013; Jin, Jin, & Kim, 2010; Bhattacherjee, 2001b). The ECM holds that the continuance intention of users is formed by satisfaction with using the IS and also their perceived usefulness of continued IS use (Weng, Zailania, Iranmanesh & Hyun, 2017). Lee (2010) maintains that users being satisfied with the IS use is very significant in forming the IS continuance behaviour.

Luqman, Razak and Ismail (2014) opined that continuance intention construct is measured after the actual usage has taken place, it can also be considered as the post-acceptance construct that is postulated in the original ECM. Bhattacherjee (2001b) proposed the concept of continuance intention in the perspective of accepting a novel technological system. Thus, proposing that users have a tendency to use it incessantly when they are satisfied with initial experiences of usage. Continuance intention is related to a consumer's repurchase decision because both judgments about a product follow a prior choice, whether to accept or purchase and are influenced by the initial use of IS and experience (Bhattacherjee, 2001a). According to Al-Maghrabi and Dennis (2009), in a continuance intention situation, the user is usually able to understand a feeling very swiftly whether or not all appear to be in order. Continuance intention is an important measure to study; it ascertains whether users have a future tendency toward using IS beyond their prior experiences (Joo, So & Kim, 2018).

Empirical evidence of Liu (2014) on IS continuance revealed that user satisfaction is a major factor of IS continuance intention, influenced by the strongest predictor which is satisfaction, followed by perceived usefulness and confirmation. The IS continuance model was also empirically validated by Assensoh-Kodua and Lekhanya (2014), when their results revealed that continuance intention is determined by satisfaction and perceived usefulness of continued IS use. User satisfaction is, in turn, subject to confirmation of expectation from prior IS use and perceived usefulness. The Lu, Yu, Liu and Wei (2017) model claims that user continuance intention is motivated by perceived usefulness, expectation, perceived effort expectancy and continuance intention. Also, perceived performance expectancy established a significant factor of continuance intention. The research model of Wu and Chen (2017) revealed that perceived usefulness is a major mediator of continuance intention of use of IS.

Wu and Chen (2017) opined that users' behaviour which includes the perception and extent to which IS meet the needs of users are predictors of continuance intention. Ramayah, Ling, Taghizadeh and Rahman's (2016) study revealed that the continuance intention of IS was reported to be dependent on the relative benefit of an IS. They submitted that the greater the perceived relative benefit of using an IS, the greater the continuance intention. Subsequently, the study of Guo, Xiao, Toorn, Lai and Seo (2016) revealed that there was a significant indirect correlation between flow and continuance intention through the perceived hedonic value of IS users. Perceived hedonic value played the most important mediating role, transmitting the effects of flow on continuance intention. The continuance intention has become a significant matter of study influencing the behavioural intention of overweight adults' continuous use of wearable devices for sustained health monitoring. However, compared to the abundant research on initial adoption, the continuance intention of wearable devices has rarely been studied, which involves great indecision and threat that may hinder users' continuance usage (Yuan, Liu, Yao & Liu, 2014). The subsequent section will identify other factors that can influence behavioural intention of overweight adults to use wearable device.

4.4 Other Factors Influencing Behavioural Intention of Overweight Adults' to use Wearable Devices for Self-Monitoring

The existing literature has shown that confirmation, perceived usefulness and satisfaction were three major factors that influence overweight adults' continuance intention of using wearable devices for health monitoring. This study has provided extra factors such as perceived aesthetic designs, privacy and security to support the robustness of the ECM. The factors also contribute to overweight adult's behaviour intention to use wearable devices for self-monitoring.

4.4.1 Perceived aesthetic designs

The term aesthetic usually denotes two diverse concepts, namely, aesthetics design and aesthetic experience (Haug, 2018; Crilly, Moultrie, & Clarkson, 2004). Aesthetic design defines user experience and emotions such as fun, pleasure as well as frustration, these are determinants of continuous and behavioural intention of IS (Norman & Ortony, 2003). Aesthetics design of wearable devices is fundamental factors of acceptance and continuous intention to use wearable devices for sustained health monitoring due to the device's intuitiveness (Liu, Vega, Maes & Paradiso, 2016; Reimann, Zaichkowsky, Neuhaus, Bender, & Weber, 2010).

The product's aesthetic design relates to how the product appeals to the senses. The latter aesthetic experience relates to a specific aspect of cognitive reaction and the sensitivity of users to how attractive or unattractive a product is (Crilly *et al.*, 2004). Aesthetics in human-computer interaction is essential for a better understanding of the user experience, especially against the background of recent changes in human-computer interaction (Sonderegger & Sauer, 2015). The ECM does not reflect perceived aesthetic design as an essential feature of acceptance determinants. Research on aesthetics started in the 18th century and Alexander Gottlieb Baumgarten is considered as being the founder of this research field (Mumcu, & Kimzan, 2015). Aesthetics is a different division of the rational thought system, Baumgarten defined aesthetics as a philosophy of attractiveness and concept of sensitive knowledge (Mumcu *et al.*, 2015; Wessell, 1972).

Hwang, Chung and Sanders (2016) reported that perceived aesthetic attributes are significant predictors of an attitude of users towards IS. Lee's (2010) study shows how users' continuous intentions and preferences to use wearable devices were positively influenced by the aesthetics design. Mumcu *et al.* (2015) opined that aesthetic experiences are associated with emotional reactions. Emotional reaction greatly influences users' continuous intention of wearable device usage (Dunne, Profita, Zeagler, Clawson, Gilliland, Do, & Budd, 2014). Thus, perceived aesthetics are a vital factor to capture customer attention and create a positive emotional reaction to enhance the customer's satisfaction and continuous intention of use. Sonderegger *et al.* (2015) reported that the aesthetics experience of IS had an influence on how its usability was perceived by the user. To this end, aesthetics and appearance of wearable devices for self-monitoring are vital and have a significant influence on user's behavioural intention.

4.4.2 Privacy and security

There are numerous factors that determine overweight adult's continuous intention to use wearable devices, two of such are privacy and security (Piwek *et al.*, 2016). Mottim and Caine (2015) explain that the technological domain is not excluded from privacy concerns, but privacy issues related to wearable technologies are somewhat new. Pfeiffer *et al.* (2016) explained privacy and security as factors influencing a user's continuous intention. They denote the general aspects for a protected wearable device regarding data collection, storage, transmission, confidentiality, integrity, accountability, and privacy (Mottim, & Caine, 2014). Privacy and security are of paramount concern, especially with wearable devices that collect health and medical information. The recent privacy fears relating to wearable devices are posing as threats to users' continuous intention (Salah, MacIntosh & Rajakulendran, 2014).

DuFour, Lajeunesse, Pipada and Xu (2016) examined users' levels of concern about data security, and how significantly data security and privacy might alter their desire to use wearable fitness trackers. Their findings indicated that users' responses to data security are a significant factor that influences continuous intention to use wearable fitness trackers. Privacy and security of personal data generated by users of wearable devices remain problematic (European Commission, 2016). Users felt they buy wearable devices and generate the data that manufacturers of wearable devices collect, store and later sell to a third party (Piwek, 2016).

In the study of PWC (2014), potential breaches of privacy and security are users' main concerns. The findings from their study indicate that 86% of users showed serious concerns about privacy and security, this also influenced their continuous intention of wearable devices usage. Security concerns such as theft of data from the device by unauthorised parties, theft of data generated by wearable devices that are stored in cloud networks are the factor influencing users' continuous intention (Popat, & Sharma, 2013). Beltramelli (2015) and Kumar and Lee (2012) in their studies identified privacy and security as two of the issues affecting users' continuous intention of wearable devices as users considered their personal information sensitive and of higher priority to them. Gribel, Regier and Stengel (2016) reported that the major reasons for resistance towards wearable devices are potential security and privacy violations. The study of Acquisti, Gross and Stutzman (2011) identified privacy and security as part of the five top vital concerns that users consider important in the wearable technology continuous usage. Furthermore, Sconce (2016) submitted that mistrust of wearable technology by users poses a serious challenge to their behavioural intention as a result of data insecurity.

Grand View Research (2016) submitted that privacy and security issues are two of the major challenges in wearable devices which are already influencing behavioural intention of users and in the next few years may affect the growth of wearable technology. Boscart, McGilton, Levchenko, Hufton, Hollidayand and Fernie (2008) reported users' insecurity as a significant factor in the continuous usage of the wearable device. They further expressed that users were cautious about the type of information collected by the device. Also, users were feeling uncomfortable in accessing and sharing their data via wearable devices. Interestingly, a survey conducted by PWC (2015) yielded contra-indications that users did not seem very deterred by the security concerns, with just 4% reporting that security would be the most important criterion in the decision-making as to whether to continue using the wearable device or not. Thus, the other 96% of users who showed a lack of concern would be more easily disposed toward continuous intention to use wearable devices for self-monitoring.

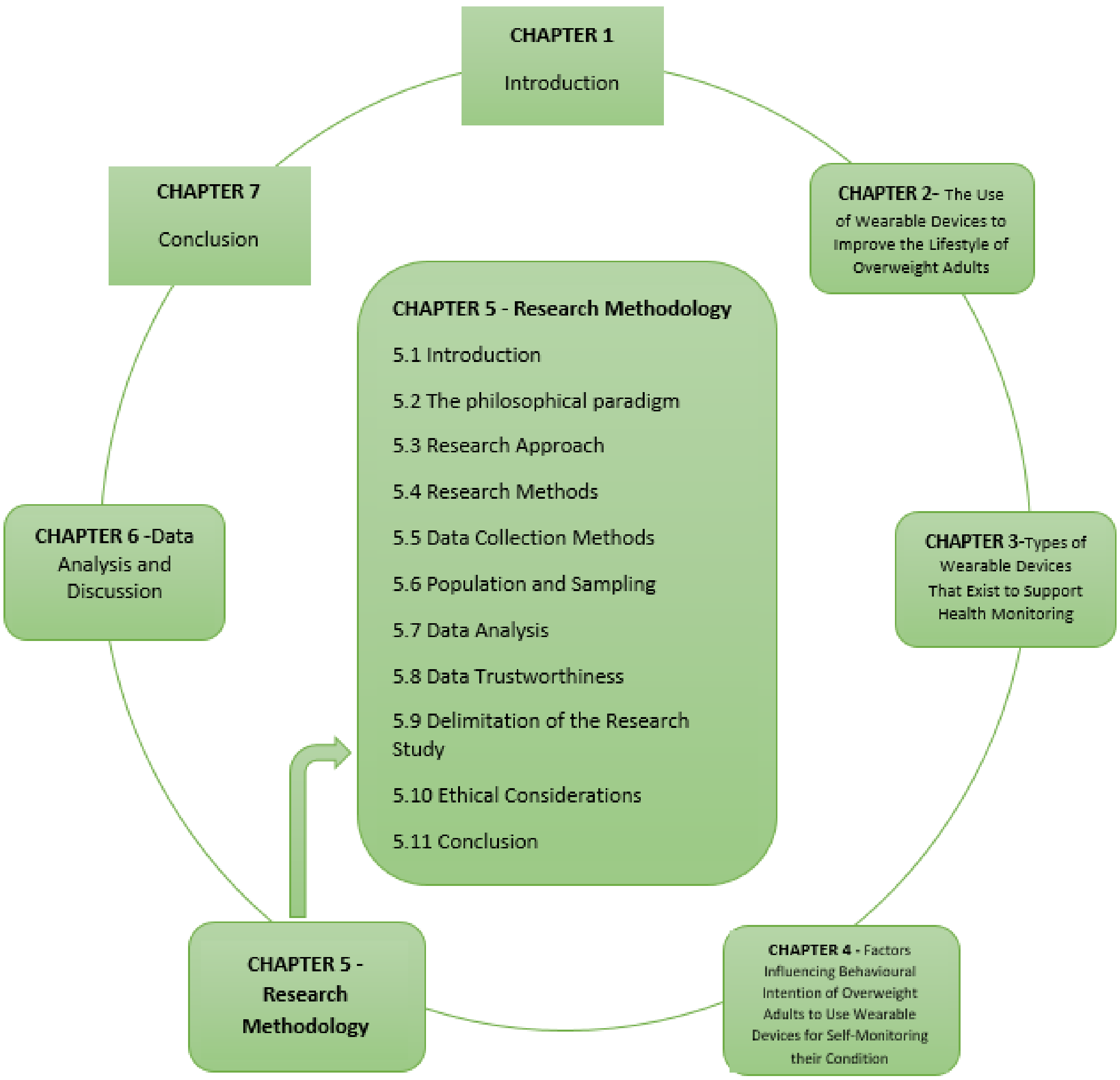
4.5 Conclusion

This chapter examined the factors that influence behavioural intention of overweight adults to use wearable devices for self-monitoring. The Expectation Confirmation Model (ECM) was used by various researchers to adequately understand users' satisfaction and their post-adoption behaviour.

The ECM posits that overweight adults' continuance intention of wearable devices usage is focused on three elements. These elements are satisfaction with the wearable devices, the degree of their confirmation, and post-adoption behaviour which is determined by perceived usefulness. The findings from literature revealed that satisfaction is the strongest determinant of overweight adults' continuance intention to use wearable devices, followed by perceived usefulness. Also, confirmation has previously been validated as the third factor inflicting behavioural intention of use of wearable devices. Overweight adults' expectation confirmation is positively connected to their perceived usefulness. Perceived usefulness is more closely associated with acceptance intention, whereas satisfaction plays a significant part in continuance intention.

Consequently, in order to increase continued usage of wearable devices, literature suggests that most research was only focused on aesthetics design of the device and relating it to behavioural intention. The chapter further identified privacy and security as major contributory factors influencing the behavioural intention of overweight adults' to use wearable devices. The majority of studies identified privacy and security as inhibitors influencing user's behavioural intention of wearable devices for self-monitoring. Nevertheless, manufacturers of wearable devices need to begin to take the matters of user's privacy and security more seriously than they have in the past.

CHAPTER 5



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CHAPTER 3-Types of Wearable Devices That Exist to Support Health Monitoring
CHAPTER 4 - Factors Influencing Behavioural Intention of Overweight Adults to Use Wearable Devices for Self-Monitoring their Condition
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Research Methodology

5.1 Introduction

As stated in Chapter 1, the fundamental objective of this study was to **examine the factors influencing behavioural intention of overweight adults' in South Africa to make use of wearable devices for sustained health monitoring**. Clough and Nutbrown (2012, p. 39) explain research methodology as a "critical design attitude to be found always at work throughout a study, rather than confined within a brief chapter called 'Methodology'". The essence of research methodology is to serve as a roadmap and guideline of how the researcher derived his/her research outcome (Hofstee, 2006). Amrollahi, Ghapanchi, and Talaei-Khoei, (2014) argue that research entails argumentation, observation and establishment of a link between newly identified and existing knowledge in a field of study. Adopting the right methodological approach will be significant in addressing the factors influencing behavioural intention of overweight adults' in South Africa to make use of wearable devices for sustained health monitoring.

In order to provide direction to this study, the study adapted the research onion as proposed by Saunders, Lewis and Thornhill (2016) to provide a logical order to the discussion in this chapter. The research onion is divided into six layers with specific themes, namely, the research philosophy; the research approach and strategy; the methodological choice; the time horizon and the data collection and analysis techniques. The research onion provides a clear picture of the progression and transition within which a research method can be designed. Figure 5.1 illustrates how these layers were used in this study.

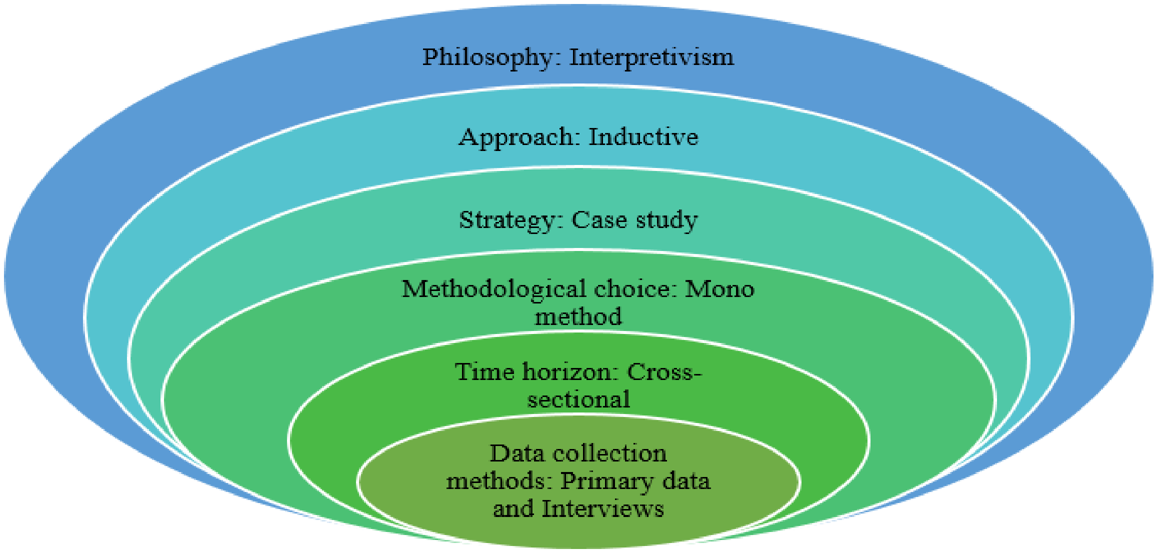

Figure 5.1: Application of Research Onion to this Study (Adapted from Saunders *et al.*, 2016)

Therefore, this chapter will follow the six layers of the research onion starting with the explanation of the philosophical stance underlying the study. A comprehensive discussion of the research approach and design is presented in this chapter. A qualitative data collection method was adopted as the methodological choice for this project. Also, a cross-sectional time horizon was applied in this study. Lastly, the techniques and procedure adopted in the study are primary data and interviews. In the section that follows, the research paradigm that was employed will be explained.

5.2 The philosophical paradigm

Carrying out a research involves the development of a research paradigm (Richardson, & Robinson 2007). The concept of a philosophical paradigm emerged from the work of Thomas Kuhn who explained it as "a set of general philosophical assumptions about the nature of the world and how we can understand it, assumptions that tend to be shared by researchers working in a specific field" (Maxwell, 2005, p. 36). A research paradigm is a common framework for research and theory that consists of fundamental premises, essential issues, and a description of quality research (Creswell & Poth, 2017; Neuman, 2013). Thanh and Thanh (2015) add that the philosophical paradigm comprises three aspects which are a methodology, criteria for validity and a belief about nature of knowledge. The application of the chosen philosophical paradigm adds to the validity of a research study, as it is entrenched upon accepted methods (Olivier, 2009). Thus, it is significant to note that philosophical paradigms play an essential part in social sciences research. There are four core philosophical assumptions that need to be considered so as to determine an appropriate paradigm for a research study. These include assumptions of ontology, epistemology, axiology and methodology (Thanh & Thanh 2015; Scotland, 2012; Wahyuni, 2012). The four philosophical assumptions are discussed below.

Ontology is concerned with the nature of social phenomena and beliefs relating to reality (Saunders *et al.*, 2016; Denscombe, 2010). Ontology can be described as "a branch of philosophy concerned with articulating the nature and structure of the world and it specifies the form and nature of reality and what can be known about it" (Wand & Weber, 1993, p. 220). The ontological assumption explains whether reality exists because of natural laws or as a construction of human thought and experience (Krauss, 2005).

Epistemology is "concerned with providing a philosophical grounding for deciding what kinds of knowledge are possible and how we can ensure that they are both adequate and legitimate" (Maynard, 1994, p. 10). Ritchie, Lewis, Nicholls, and Ormston (2014) describe epistemology as the techniques of knowing and learning about the social world and target questions on what the basis of knowledge is and how we can know about reality.

Axiology Saunders *et al.* (2016) describe axiology as the philosophical assumption that influences the idea and interpretation of realities. Scotland (2012) adds that axiology presents an account to which the views of the researchers are reflected in the research. This study discusses some of the relevant existing interpretations and biases regarding the behavioural intention of overweight adults' to use wearable devices for sustained health monitoring.

Methodology is concerned with the different research instruments that are used in collecting and interpreting data in order to answer the research question (Scotland, 2012). These research instruments must be methodologically employed before any generalisation can be made from the study outcomes. There are some dominant classifications of philosophical paradigms that can be adopted by Information Systems researchers. These are, namely, the interpretivist paradigm, positivist paradigm, critical theory and design science (Ritchie *et al.*, 2014; Myers 2013; Oates, 2006). But, this research will focus on the interpretivist and positivist philosophical paradigms. The following section examines the two commonly used philosophical paradigms:

5.2.1 Positivist paradigm

The positivist paradigm is an epistemological position of the natural scientists that advocates a relationship between the world and the researcher's view of social reality (O'Reilly & Kiyimba, 2015; Upadhyaya 2013). The postivist paradigm promotes the belief that the world can be examined objectively. Upadhyaya (2013) adds that the positivist paradigm relies on the researcher's capability to form hypotheses, investigate the hypotheses on current social reality and thereafter anticipate events based on actual relationships and patterns. Saunders *et al.* (2016) state that the opinions of the researchers do not in any way influence the results of the study. The methods of enquiry commonly employed by positivist researchers include: laboratory experiments, quantitative analysis, nomothetic experiments, deduction and confirmatory analysis (Ryan & Julia, 2007). To this end, the researchers are neutral observers and facts are not modified based on their personal beliefs and values. The following section discusses the philosophical paradigm selected for this study, namely, the interpretivist paradigm.

5.2.2 Interpretivist paradigm

Walsham (2006) describes interpretivism as a paradigm that reflects the domain of human action and the behaviour of respondents in the real world. Contrary to the positivist paradigm, the interpretivist paradigm allows the researchers to formulate interpretations of social reality and practices in their natural setting (Urquhart, 2013). The aim of an interpretivist researcher is to recognise human beliefs and values in a social context. Interpretivism brings in a unique approach to carrying out research which is contrary to the motion of explicit observation which people always use when doing research (Ritchie et al., 2014). The interpretivist paradigm is usually linked with qualitative research methods, while the positivist paradigm is often associated with quantitative methods (Bryman, 2008). Figure 5.2 below, illustrates the choice of the philosophical paradigm for this research and how the assumptions differ between positivist and interpretivist approaches.

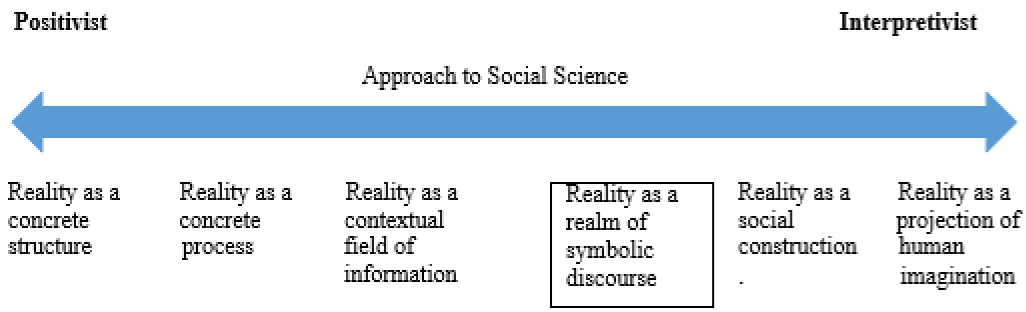

Figure 5.2: Continuum of Core Ontological Assumptions (adapted from Collis & Hussey, 2013)

This study is most appropriate in the fourth stage of the continuum: *"Reality as a Realm of Symbolic Discourse"*. The interpretivist paradigm requires a qualitative method because it allows the researchers to ask questions about what, how and why (Collis & Hussey, 2013). Tuli (2010) explains that the interpretivist researchers can make use of life history, grounded theory, ethnography, a case study and phenomenology in conducting a research study. Applying these approaches allows the researchers to compile comprehensive information about the individuals being studied so as to obtain an insider's belief. Drawing inferences from the above, this study aligns itself with the interpretivist paradigm because it established individuals' interpretations relating to behavioural intention of overweight adults to make use of wearable devices for sustained health monitoring. Also, semi-structured interviews that fit with interpretivism were used to understand the subjective meanings influencing the continuance intention of overweight adults to use wearable devices. Table 5.1 below presents the application of the philosophical paradigm to this study as explained in Section 5.2.

Table 5.1: Applying Research Philosophical Paradigm to the Study (adapted from Vaishnavi & Kuechler, 2015; Collis & Hussey, 2013)

Paradigm	Positivist	Interpretivist	Application to this study
Ontology	Reality is objectively supplied, uncertain, but knowable	Multiple realities from socially different human experiences which may be true	Participants had different narratives and experiences in the use of wearable devices for sustained health monitoring
Epistemology	Research carried out independently of researcher	Participatory Interaction exists between the subject of research and the researcher	The researcher interacted with the selected users of wearable devices in order to understand their symbolic understanding and discourses of wearable devices for sustained health monitoring
Axiology	Research is unbiased, universal and certain	Research is NOT value free or free from biases	The narratives and discourses of the selected users of wearable devices for sustained health monitoring were informed by their subjective and biased orientations about wearable devices for sustained health monitoring
Methodology	Mainly quantitative methods, observatory, manipulative, and through verification of hypotheses	Mainly participatory, qualitative, explanatory and rationalistic	Qualitative research method was adopted in order to understand the subjective narratives and discourses of the selected users of wearable devices for sustained health monitoring

The following section explains the study's approach.

5.3 Research Approach

An inductive or deductive approach can be adopted while conducting a research study. An inductive approach involves data gathering and formulation of theory based on the outcome of the researcher's data analysis (Saunders *et al*., 2016). On the other hand, a deductive approach involves the utilisation of literature to describe theories and propositions particularly designed for the aim of its testing (Saunders *et al*., 2016). In this research, inductive reasoning was applied with a view to understand the behavioural intention of overweight adults to make use of wearable devices for sustained health monitoring. Thus, to adequately address the research question, the inductive approach allowed the researcher to utilise both primary and secondary data collection methods. The next section explores the research methods.

5.4 Research Methods

Myers (2013) refers to research methods as a blueprint of enquiry that moves from fundamental beliefs to research design and collection of data in a study. Although there are several discussions of issues regarding the appropriate research modes that can be applied in a study, there are two commonly used methods researchers can follow; these are quantitative and qualitative methods. However, some studies make use of both the qualitative and quantitative methods in a singular research; this is termed mixed methods (Saunders *et al*., 2016). The following section will further illustrate the different types of research methods.

5.4.1 Quantitative research methods

The quantitative method, according to Brannen (2017), influences the natural scientific method in the human behavioural study which is exclusive to what can be measured and observed objectively. The quantitative research can be explained as a method that emphasis quantification in the analysis and data collection (Bryman, 2015). Studies conducted quantitatively generally uses statistical, computational or mathematical techniques to determine the relationship between variables in a controlled environment. Quantitative research method is associated with deductive reasoning and the positivist's paradigm (Saunders *et al.*, 2016; Bryman, 2015). Malhotra, (2012), indicates that the method involves questioning respondent's opinions in a structured form that will allow the researcher to generate data around a particular phenomenon. The method was not suitable for this study as the study used semi structured interviews for data collection which are only suitable for qualitative method.

5.4.2 Qualitative research methods

Bradley (2013) refers to qualitative research as the use of an approach that aims to derive robust insights from the existence of opinions and beliefs within similar contexts. This approach explores the human experiences and the factors that determine socio-cultural phenomena (Creswell, 2014; Wiid, & Diggines, 2013). In this study, this method was adopted to collect and analyse data. Bradley (2013) posits that studies conducted qualitatively do not measure a number of opinions or beliefs, but rather aid in providing the explanation to the dominant perception. Qualitative research involves contextual discovery, inductive logic, complexity, exploration and a selection of empirical materials (Mertens, 2010). Creswell (2014) further indicates that qualitative studies mainly use interviews, expert reviews, surveys, reviews of related literature, case studies, social experience and different types of observation techniques in the collection of data.

This study applied the qualitative method which is consistent with the interpretive paradigm. The focus of the researcher was on understanding and interpreting factors that influence behavioural intention of overweight adults to make use of wearable devices for sustained health monitoring. The approach allowed an interaction between the researcher and users of wearable devices. To this end, a valid examination of the research problem was done via a qualitative method of analysis.

5.4.3 Mixed methods research

Mixed methods research involves the combination of qualitative and quantitative research methods in a singular study (Saunders *et al*., 2016). Creswell (2014) opines that the consolidation of both methods provides a strong understanding and valid analysis of the problem statement rather than a singular technique. Mixed methods researchers often use exploratory, convergent, embedded, explanatory, multiphase and transformative design to collect data in an information systems study (Creswell, 2014). Johnson and Onwuegbuzie (2004) argue that the goal of combining both techniques (qualitative and quantitative) is not to get rid of either of the techniques, but rather to leverage on the advantages in both of these techniques which will minimise their inherent weaknesses. The use of both methods allows the research question to be addressed from an array of perspectives leading to greater authenticity of the research outcome (Wiid, & Diggines, 2015). This method was not adopted in this research as the research applied the qualitative research methods. The following section explores the data collection methods.

5.5 Data Collection Methods

Data collection involves initiating strategies for recording information, gathering of information via structured, semi-structured or unstructured interviews, visual materials and documents, observation as well as setting the boundaries for the research (Creswell, 2014). The information collected is determined by the analytical techniques used to produce the research findings (Paradis *et al*., 2016). Data collection methods can be generally classified into primary and secondary data. This research collected both secondary and primary data to examine the factors influencing behavioural intention of overweight adults' in South Africa to make use of wearable devices for sustained health monitoring. The subsequent sections will explain both secondary and primary data collection methods.

5.5.1 Secondary Data

Secondary data is referred to as the collection of existing data and methods which contain information about the subject domain and problem statement from sources such as reports, documents, academic journals, books, and conference proceedings (Saunders *et al*., 2016). Reviewing secondary data allows the researcher to appraise the appropriateness of literature for the study at hand (Wiid, & Diggines, 2015). This research used relevant literature from studies that had been carried out previously in the wearable devices domain. Additionally, research study keywords such as '*wearable devices', 'fitness and wellness trackers', 'overweight adults', 'behavioural intention', and 'sustained health monitoring'* were used in the search. The pieces of literature used in this study were downloaded from various sources such as ACM, Pubmed, Science Direct, Sage, and Google Scholar. To this end, the collection of relevant literature facilitated the development of an interview guide which was administered to the users of wearable devices.

5.5.2 Primary Data

In contrast to secondary data, Surbhi (2016) and Wiid and Diggines (2015) refer to primary data as unpublished data as well as data collected from original sources by the researcher from the respondents specifically for the present research project. Researchers can collect primary data from respondents through focus groups, case studies, observation, surveys, experiments and interviews (Driscoll, 2011).

For the purpose of this study, semi-structured interviews were employed in order to examine the factors influencing behavioural intention of overweight adults' in South Africa to make use of wearable devices for sustained health monitoring. This provided the researcher with the opportunity to pursue a thorough understanding of the topic and to further explore respondents' responses.

5.5.2.1 Interviews

Saunders *et al.* (2016) describe interviews as a data collection technique that uses premeditated dialogue between two or more individuals. It involves the application of verbal or oral exchange of information between the researcher and the research respondents (Yin, 2015). Interviews are vital for obtaining information behind a respondent's experience. Interviews can be classified into three groups namely; structured, unstructured and semi-structured interviews (Saunders *et al.*, 2016):

A structured interview is based on a prearranged and fixed set of questions that mainly use 'yes' or 'no' type of answers from the research participants. The structured interviews' answers are mostly recorded on a standardised schedule.

An unstructured interview, contrary to a structured interview, does not involve a set of predetermined questions. The respondent is given the opportunity to communicate without restriction about the subject domain.

A semi-structured interview is the composition of structured and unstructured interviews. It involves the use of a list of standardised themes and questions, while adequate opportunity is given to the respondent to talk freely about the subject domain raised by the researcher. The application of semi-structured interview in a study will allow the researcher to probe and expand participants' responses. The sequence of questions can be varied depending on the progress of the questioning.

The brief explanation of classification of interviews influenced the choice of the most appropriate interview type for this study. Thus, for this research, a semi-structured interview was employed to obtain a deep insight into how overweight adults' behavioural intention to make use of wearable devices can be influenced for sustained health monitoring (see Appendix C). The interview questions were adapted from the Expectation Confirmation Model (ECM) constructs in order to address the research questions. Additionally, traditional one-on-one interviews were conducted by the researcher and permission was asked from the respondents to audio-record their responses about the subject domain. Respondents' personal data collected through the wearable device was not considered in this study. Lastly, the purpose of these interviews was to understand the factors influencing the participants' behavioural intention and usage of wearable devices. The population and sampling for this study is explained in the next section.

5.6 Population and Sampling

According to Oates (2006), the research characteristics and objectives of the study population and sampling determine the number of respondents to select. It is vital to understand the population sample size of a specific study before commencing with the research. A suitable population and sampling methods are crucial for the trustworthiness of the study (Marshall and Rossman, 2011). The use of appropriate sampling in a study will enhance the feasibility and accuracy of data collected from the respondents (De Vos, 2011). Thus, the population used in this research project were overweight adult who are users of wearable devices in East London, South Africa. Keikhosrokiani *et al*. (2015) had similarly used respondents who are smartphone users to study user's behavioural intention toward a mobile healthcare system.

Furthermore, research sampling techniques can be classified into two types namely; probability and non-probability (Alvi, 2016). Probability sampling indicates that an entire component of the population has a known non-zero likelihood of being included in the sample (Lacobucci, & Churchill, 2018; Alvi, 2016). It is vital for the selection of a population to be equal and exactly defined. Stratified sampling, cluster sampling, systematic sampling, multistage sampling and simple random sampling are techniques of probability sampling (Alvi, 2016). This form of sampling technique is mainly applied in positivist studies in order to achieve the reliability and validity of the study outcome. Nevertheless, this study concentrated particularly on the non-probability sampling and it was adopted to determine the sample size.

5.6.1 Non-Probability Sampling

Berndt and Petzer (2011) view non-probability sampling as a subjective and arbitrary sampling technique. It uses subjective techniques because not every individual in the population will possibly be selected in the research study. This technique is frequently applied by researchers because the process of choosing a sample is relatively cheaper and faster compared to probability sampling (Etikan, Musa & Alkassim, 2015). Also, the sampling method to be employed by the researcher largely relies upon the purpose, nature and type of study. This type of sampling method is generally used in interpretivist studies in order to establish the credibility, transferability, dependability and conformability of the research outcome. Alvi (2016) identifies snowball, quota sampling, convenience sampling, matched sampling, purposive sampling, volunteer sampling and genealogy-based sampling as methods of non-probability sampling. However, this study employed purposive sampling to identify overweight adults' that are using wearable devices for sustained health monitoring.

5.6.1.1 Purposive Sampling

Purposive sampling is a technique in which the researcher consciously and purposively identifies participants that he/she considers to be knowledgeable about the study questions (Lewis, & Sheppard, 2006). This technique was chosen because the sample units have distinct characteristics or features which enable a thorough understanding of the subject domain and objectives that are being examined (Ritchie *et al*., 2013). This sample format is usually applied when dealing with very small sample sizes such as we have in this case study, most importantly when such cases are particularly informative by nature (Neuman, 2013).

In summary, the sample size for the study participants were 20 overweight adults aged between 18 – 59 years living in East London, South Africa, who were also users of fitness tracking devices. Overweight was determined by using the respondents' body mass index (BMI). The WHO (2016) guidelines state that people with a BMI between 25 kg/m^2 and 29.9 kg/m^2 can be considered to be overweight. The BMI is determined by dividing the respondent's weight by his/her height. An advertisement was placed on social media platforms in order to find volunteer respondents. All volunteer respondents were asked for permission to measure their weight and height prior to the commencement of the interview. Thereafter, interviews were conducted. The following section discusses the data analysis for this study.

5.7 Data Analysis

Data analysis involves an elaborate method of examining the relationship between concepts, elucidating and isolating elements of collected data and incorporating the findings in a manner that answer the research question (Leedy, & Ormrod, 2013). Isabirye (2016) explains that the essential idea of a qualitative study is that the data should be employed to justify and strengthen the researcher's stance and not to disapprove or prove it. Ibrahim (2012) highlights two standards that a researcher must follow during analysis of qualitative data. The standards include the organisation of raw data into tables and the ability of a researcher to link the relationship between the study objectives and findings. Lichtman (2013) and Tesch (2013) argue that there are various ways of carrying out qualitative data analysis and researchers do not have to adhere to any strict standards of analysis. Thus, this study applied thematic analysis to examine the qualitative data collected from users of wearable devices.

5.7.1 Thematic Analysis

Thematic analysis is mainly used for documenting patterns or themes, examining, pinpointing and identifying meanings within the data (Ibrahim, 2012; Braun & Clarke, 2006). It is often considered as most applicable for any research that aims to discover interpretations and contextual meaning about a subject domain. For this reason, thematic analysis assists in describing and linking the relationship between the data collected and the findings of this research. The data provided by respondents were organised into relevant themes to address the research question. This study adopted the six phases of data analysis developed by Braun and Clarke (2006) during the analysis process. The subsequent section will briefly explain how these phases were conducted during the analysis, beginning with familiarisation with data.

Familiarisation with data is the stage of data analysis which commences just after the data collection (Braun, & Clarke, 2006). At this phase, the researcher attempts to become familiar with the data collected during the interviews by transcribing it into a written form in order to have a thorough insight into the data.

Generating initial codes is a stage that occurs once the researcher has familiarised him/herself with the data, and develops a list of ideas of what is fascinating about it (Braun & Clarke, 2006). Marshall and Rossman (2015) describe data coding as markers used in giving meaning to groups of collected data. The coding of data assisted the researcher in validating and gaining significant understanding into the data meanings.

Searching for themes involves categorising the different codes into probable patterns, and arranging all the appropriate codes with the selected themes (Braun & Clarke, 2006). The selected themes and patterns explain what the researcher understands to be the views of the respondents (Marshall, & Rossman, 2015).

Reviewing themes is concerned with refinement and further examination of identified themes. Braun and Clarke (2006) classified the process of reviewing themes into two levels. These levels are reviewing the extracts for each theme as well as considering the validity of each theme in connection with the data set. The themes identified were then verified to see if they answered the question of how the behavioural intention of overweight adults in South Africa to make use of wearable devices can be influenced for sustained health monitoring.

Defining and naming themes involves the process of conducting an all-encompassing analysis of individual themes and it is subsequently followed by the naming of each theme (Braun & Clarke; 2006). Boyatzis (1998) explains that the researcher can finalise the naming of each theme by showing a few excerpts from the initial text in order to give the reader meaning of what the themes cover.

Producing the report is the final phase of data analysis which involves the combination and description of all the appropriate themes. The aim of producing a report is to convince the reader in a manner which give credence and validity to the researcher's analysis (Braun & Clarke; 2006). This was achieved by discussing and reporting the outcome of the analysis in a contextual approach that supported the purpose of the research. The data trustworthiness for this research is discussed in the next section of this chapter.

5.8 Data Trustworthiness

The benefit of a qualitative study is the richness of information collected from respondents and such data must be transcribed in a well-grounded and valid method (Moretti *et al*., 2011). The integrity of a research study is essential in assessing its quality (Lincoln, & Guba, 1985).

Trustworthiness of data is driven by four criteria: credibility, transferability, dependability and conformability.

Credibility is generally employed to examine non-numeric data and refers to the subjective and objective elements of the integrity of information (Cai & Zhu, 2015). "Credibility involves establishing the results of qualitative research as credible or believable from the perspective of the participant in the research" (Trochim, & Donnelly, 2007, p. 149). Mertens (2010) explains that findings from a study must be based on adequate data collection as well as effective data analysis and interpretation. With regards to credibility, data collected from academic journals, articles and interview response from overweight adults were analysed effectively to support the validity of this study.

Transferability is the degree to which the outcomes of a qualitative study can be reciprocated to other perspectives or backgrounds (Trochim, & Donnelly, 2007). Lincoln and Guba (1985) describe transferability as an idea that allows readers of a study to make evaluations based on uniformity and differences when contrasting the study to their own. Transferability in research allows the applicability of findings of a particular study to another research context. Thus, the theoretical perspective, research methodology and design of this research can be replicated in another context in future research.

Dependability is the qualitative parallel to authenticity of research findings (Lincoln, & Guba, 1985). Tobin and Begley (2004) explain that dependability allows the engagement of respondents in examining the interpretation and the findings as well as the recommendations of the research in order to verify the data collected by the interviewer. Moretti *et al.* (2011) maintain that it is essential to clearly explain methods and bases used to choose respondents and present the respondents' key attributes. Relevance and quality of a research study can be confirmed through a dependability audit (Mertens, 2010). Dependability emphasises the appropriateness of findings over time and under different circumstances. Therefore, this study strictly follows the best practices of qualitative studies by ensuring that personal views of the researcher did not interfere with data collection and analysis of the study.

Conformability highlights the degree to which the study findings could be authenticated or validated by other researchers (Grima-Farell, 2017; Trochim, & Donnelly 2007). Conformability ensures that the data collected and their interpretations are not a fabrication of the researcher's thoughts, but precisely originated from the data (Cohen, Manion & Morrison, 2017). Mertens (2010) explains conformability as the researcher's ability to trace data collected to its original source, while the logic adopted to explain the data collected must be without any form of ambiguity. Therefore, the current research findings conform to existing knowledge and the researcher was subjective in the collection and analysis of data. The delimitation of this research study is explained in the next section.

5.9 Delimitation of the Research Study

This research project is focused on behavioural intention of overweight adults to use wearable devices for sustained health monitoring. The study participants were limited to overweight adults, aged between 18-59 years, living in East London, South Africa. The study respondents were limited to 20 respondents that have made use of wearable devices for health purposes in the past year. The next section will explain ethical considerations of this study.

5.10 Ethical Considerations

According to Kumar (2014), ethics deal with beliefs about what is appropriate or inappropriate when conducting a research study. Punch (2016) explains that it is the researcher's duty to make sure academic trustworthiness and integrity are achieved in a research study.

In order to ensure that academic trustworthiness and integrity were thoroughly realised and to affirm the confidentiality of the research respondents, the subsequent measures were adopted:

- The researcher received ethical clearance approval from the University of Fort Hare's Research Ethics Committee (ISA051SOGU01) (See Appendix A).
- Respondents were well-informed of the advantages and disadvantages of the study and their permission was requested before commencing the study (See Appendix B).
- Only volunteer participants older than 18 years were used for the purpose of this study.
- The participants' personal data collected through the wearable device were not used for the purpose of this study, only the behavioural intention of the participant to use the wearable device was investigated.

- The research was conducted in conformity with the academic guidelines of voluntary participation.
- Respondents were assured of their confidentiality and anonymity during and after the study.
- The data collected from respondents during the interviews were securely stored.

5.11 Conclusion

This chapter followed the six layers of the research onion, starting with the explanation of the philosophical stance underlying the study. The study adopted an interpretivist philosophy to examine the factors influencing behavioural intention of overweight adults' in South Africa to make use of wearable devices for sustained health monitoring. The fundamental principle of interpretivism is that it brings in a unique approach to carrying out research which is contrary to the motion of explicit observation which people always use when doing research.

In conducting this research, an inductive approach was used, with a view to understanding the behavioural intention of overweight adults' using wearable devices for sustained health monitoring. This was followed by a discussion of the qualitative methods selected as the research method chosen for this study. Thereafter, both secondary and primary data collection methods employed were discussed.

A semi-structured interview was chosen to pursue a thorough understanding of the topic and to further explore respondents' responses. The interview questions were adapted from the ECM constructs in order to address the research questions. With regards to the sampling of respondents, the study employed purposive sampling to identify overweight adults' that are using wearable devices in East London. The study applied thematic analysis in order to discover contextual meanings from the information obtained during the interviews. The data trustworthiness of the research project was validated by credibility, transferability, dependability and conformability of the study. Finally, the chapter ended with a discussion of the ethical considerations and measures that were considered appropriate to this research. The next chapter discusses the research findings.

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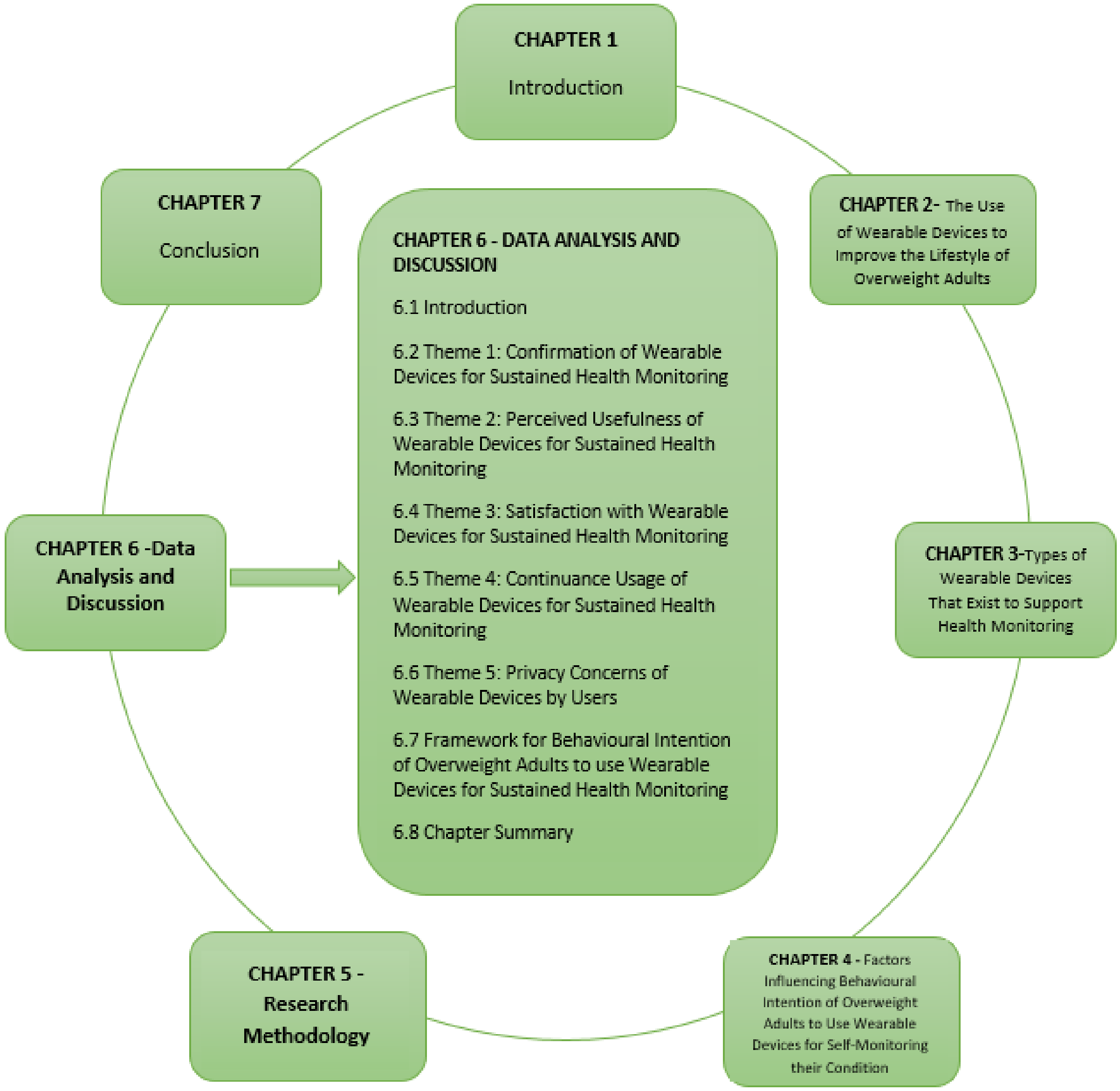
CHAPTER 6



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DATA ANALYSIS AND DISCUSSION

6.1 Introduction

The study examined the factors influencing behavioural intention of overweight adults' in South Africa to make use of wearable devices for sustained health monitoring. In order to achieve this aim, primary data were collected through interviews from 20 overweight adults and users of wearable devices between the ages of 18 – 59 years, living in East London, South Africa. Therefore, this chapter deals with the analysis and discussion of data. Before the presentations and discussion of narratives of the participants on wearable devices, it is imperative to present the usage profile of the participants.

Table 6.1: Usage Profile of The Participants

Inter-viewee	Gender	Age group	BMI	Type of Wearable Devices	Usage Duration	How participants find out about the device	Motivation to buy the device
1	Male	36 – 50 years	29.30	Nike+	4 years and 6months	Through a colleague	I'm motivated so as to shed weight.
2	Female	18 – 25 years	28.40	Garmin	6 months	Through my aunty	I wanted to lose weight and my aunty had one
3	Female	26 – 35 years	26.70	Samsung Gear fit	2 years and 6 months	Through my brother	I started being active about 3 years ago and I always needed something to give me that push in term of just to track how I'm doing if I'm in the right track and if I'm actually not.
4	Male	18 – 25 years	27.62	Samsung Gear fit	3 years	Through TV advertisement	I was motivated by the attributes which the device could perform.
5	Female	51 – 59 years	27.55	Apple iWatch	3 years	Through my niece	For activity tracking
6	Female	51 – 59 years	25.34	Garmin	2 years	Through a friend	I wanted to see how fast I can go and how I can improve on the running
7	Female	51 – 59 years	28.04	Solace	1 year	Through Google	I wanted to monitor my running
8	Female	26 – 35 years	29.74	Nike+	7 months	Through Google	I wanted something that is going to trace my weight loss journey, whether I'm doing well or badly in terms of my daily calorie loss.
9	Male	36 – 50 years	29.39	Fitbit	4 years	Through the Internet	I weigh over 110kg, and I was concerned that I was putting on so much weight and I got it to try and monitor my activities.
10	Female	36 – 50 years	29.05	Apple iWatch	1 year	Through Discovery website	I have had the device without knowing this helps for the health. I am involve in discovery vitality and I needed to make sure that I maintained my points

11	Male	26 – 35 years	29.39	Samsung Gear fit	2 years	Through my brother	I wanted to lose some weight and gain some physical fitness so I thought it could help me to maintain the way I exercise each and every day.
12	Female	26 – 35 years	29.05	Fitbit	1 year	Through a friend	I wanted to track the distance, time, and calories that I will lose when I do any particular exercise.
13	Female	26 – 35 years	25.22	Apple iWatch and Garmin	2 years and 6 Months, 1 year	Through Discovery Vitality Promotion	I needed something that will help me to monitor my pace, heart rate so that I can get points for my Discovery Vitality.
14	Male	26 – 35 years	27.99	Garmin	2 years	Through friends	I wanted to view my pace per kilometres while I'm running, calories burnt per activities. Especially my activities history.
15	Male	26 – 35 years	27.06	Huawei TalkBand B3	1 years	Through Facebook	I just wanted to monitor my wellbeing and my health status
16	Male	26 – 35 years	26.56	Samsung Gear fit	1 year and 6 months	Through a friend	I needed something that will monitor my sleeping patterns as well as motivate me to be active.
17	Female	18 – 25 years	25.63	Fitbit	1 year	Through Twitter	I needed something that can monitor my health activities.
18	Female	36 – 50 years	28.65	Bfit	3 months	Through my husband	I wanted to know how many calories I was burning during a day basically and I wanted to count everything that I do.
19	Female	36 – 50 years	29.41	Apple iWatch	2 year	Through Discovery Vitality promotion	Fitness initially, but it was on special and seemed like a nice gadget to have.
20	Male	26 – 35 years	27.90	Polar	2 year	Through friends	I needed something that will monitor my heart rate, sleeping patterns and my calories.

From Table 6.1, 40% of the participants were male; while 60% were female. This implies that the majority of the participants were female. This does not mean that females use wearable devices more than males because the sample size was only twenty since it was qualitative study; this ratio could easily change with a larger sample size. Figure 6.1 below, illustrates gender distribution of the participants.

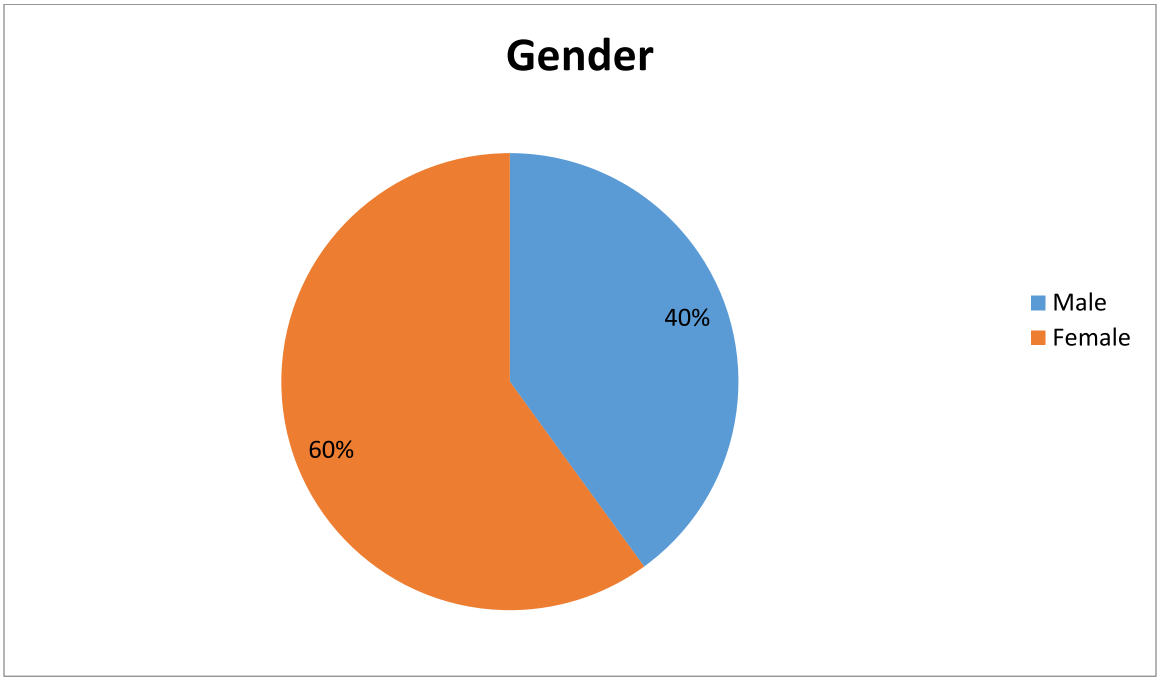


Figure 6.1: Gender Distribution of the Participants

On the age categories, 15% of the participants were between 18-25 years; 45% of the participants were between 26-35 years; 25% of the participants were between 36-50 years while 15.0% of the participants were between 51-59 years. It showed that 60% of the participants were between 18-35 years. Also, 85% of the participants were between 18-50 years; while 15% were more than 51 years. Figure 6.2 depicts the age category of the participants.

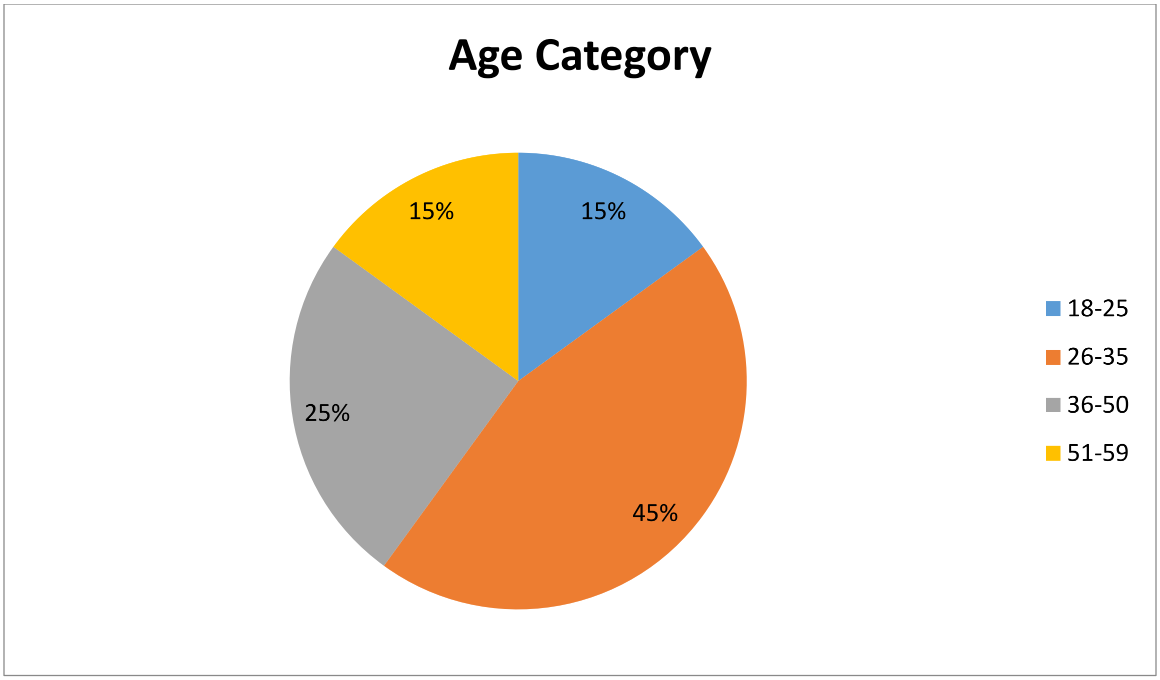


Figure 6.2: Age Category of the Participants

The average Body Mass Index (BMI) of the participants was 27.91; while the minimum was 25.20 (Participant thirteen) and the maximum was 29.4 (Participant nineteen). This indicated that all the participants were overweight adults because their BMIs were between 25.20kg/m^2 and 29.74kg/m^2. According to WHO's (2016) guidelines, people with a BMI between 25 kg/m^2 and 29.9 kg/m^2 can be considered to be overweight.

The most common wearable devices among the participants were Samsung Gear fit (20%) and Apple iWatch (20%) and Garmin (20%). Only 15.0% and 10.0% of the participants used Fitbit and Nike+ respectively. The remaining 4 participants (15.0%) used Solace, Huawei TalkBand B3 and Bfit. It should be noted that participant thirteen used both Apple iWatch and Garmin. Some studies revealed high usage of Fitbit among the users of wearable devices (Filipowicz, & Mcgraw, 2017; Schrager *et al*., 2017; Evenson *et al*., 2015). Other studies reported high usage of Nike+ (Tucker *et al*., 2015), Garmin (Dooley, 2016) and Apple iWatch (Allen, 2007) among the users of wearable devices. Also, the average duration of the usage of the wearable devices among the participants was 20 months; while the maximum duration was 48 months (Participant nine) and minimum duration was 3 months (Participant eighteen). Based on Table 6.1, most of the participants got their information about wearable devices through their relatives, colleagues, an advertisement, Internet Search Engine and Discovery Vitality. Also, almost all of the participants used wearable devices to lose weight; while others mentioned that they used wearable devices to monitor their physical activities.

Having presented the usage profile of the participants, it is imperative to present the emerging themes and sub-themes from the data and literature. However, most of these themes were developed using the expectation-confirmation model. These main themes are: (a) confirmation of wearable devices for sustained health monitoring; (b) perceived usefulness of wearable devices for sustained health monitoring; (c) satisfaction of wearable devices for sustained health monitoring; (d) continuance usage of wearable devices for sustained health monitoring and (e) privacy and security concerns. The next section discusses confirmation of wearable devices for sustained health monitoring.

6.2 Theme 1: Confirmation of Wearable Devices for Sustained Health Monitoring

Confirmation is the degree to which a user's initial expectation is confirmed by the usage of IS products (Lai *et al*., 2016). It is one of the concepts of the expectation-confirmation model which assesses the level at which the users of wearable devices confirmed the efficiency of wearable devices for sustained health monitoring. In order to confirm the various functions of wearable devices for achieving sustained health monitoring, participants were asked about the various applications of wearable devices. In order to capture the various functionalities of wearable devices for sustained health monitoring, this theme was divided into some sub-themes. These are: heart rate monitoring, physical activity, daily nutrition and dietary intake, sleeping patterns, detection of early disorders and medication adherence.

6.2.1 Sub-theme 1: Heart rate monitoring

Heart rate is the speed at which the heart beats. The average heart rate is 72 beats a minute. According to Gholipour (2018), the normal range for adults is 60-100 beats per minute. In this sub-theme, participants were asked whether wearable devices have helped them to monitor their heart rate for sustained health monitoring. This is equally important in order to further confirm whether wearable devices actually helped in monitoring health. The majority of the participants confirmed that wearable devices are useful in monitoring heart rate. While responding to this question, a male participant between the age of 18 and 25 stated that he used the wearable devices to monitor his heart-beat rate in order to improve his heart functioning. Accordingly, he expressed thus: “I often look at my heart pulse, and with the heart rate monitor you can use that to monitor your stress level; that is what I use it mostly to do - in order to check my stress level” (Participant four).

Another participant expressed that “it actually improves my heart rate monitoring because as I take a walk and everything, I will be able to become more active” (Participant ten). Based on the above empirical evidence, it can be argued that the wearable devices helped in monitoring heart rate, which is essential in achieving the goal of sustained health monitoring among the overweight adults. This agrees with the expectation-confirmation model applied in this study (Schwarz *et al*., 2016; Patricks *et al*., 2016; Cajun, & Yongliang, 2015). These authors implied that since the users of the wearable devices revealed that the devices helped in monitoring their heart rates, it could be inferred that they confirmed the importance of wearable devices for sustained health monitoring.

Also, this is in line with the existing literature on the use of wearable devices for monitoring heart rate (Kelli *et al*., 2017; Cheatham *et al*., 2017; Thubron, 2016; Dooley, 2016; Allen, & Christie, 2016; Riverview Health, 2015; Swan, 2012; Sardini, & Serpelloni, 2010). For instance, the study of Kelli *et al.* (2017) indicated that wearable devices are vital for monitoring heart rate, especially among the overweight adults. To Cheatham *et al.* (2017), wearable devices are useful in measuring heart speed. Also, Thubron (2016) found that wearable devices help users to track their heart rate via an IQ auto-detection software. Dooley’s (2016) revealed that the activity tracker uses global positioning system with an inbuilt optical sensor to measure users’ heart rate through a Mio heart rate technology (Dooley, 2016). This device offers individualised wireless health monitoring and a nonstop vital symptoms’ analysis, such as heart speed, electrocardiogram, respiration velocity, and body motion and skin temperature (Sardini, & Serpelloni, 2010).

6.2.2 Sub-theme 2: Physical activity

According to WHO (2006), physical activity is any bodily movement produced by skeletal muscles that requires energy expenditure. Some studies indicate that wearable devices are used to monitor physical activity (Coughlin, & Stewart, 2016; Naslund *et al*., 2016). All the participants agreed that wearable devices enhance and promote their physical activity levels. For instance, participant three mentioned that her wearable device had enhanced her levels of physical activities. Similarly, participant six noted that "my daily activities … have increased since I bought the device because I do physical activities every day. I found it to encourage a significant improvement in my daily activities". To participant seven, "my daily activities have been so tremendous since I started using the wearable device". In the same vein, participant eleven argued that his daily physical activities have greatly improved. Also, participant twenty expressed that his daily physical activities have significantly improved. It could be surmised that the major argument of the users of wearable devices for sustained health monitoring is that wearable devices enhance their physical activities which is required for achieving the objective of weight loss in order to avoid obesity. This is in line with the expectation-confirmation model adopted in this study, which argued that users of information technology are more likely to continue its usage if it serves their purposes (Warkentin, 2016; Thong *et al*., 2006; Bhattacherjee, 2001)

Based on the above field data, the participants stated that they are using wearable devices to enhance their physical activities. This finding agrees with literature on the use of wearable devices to enhance and promote physical activities for sustained health monitoring (Schrager, *et al*., 2017; Coughlin, & Stewart, 2016; Naslund *et al*., 2016; Ramalho, Silva, Pinto-Bastos, & Conceição, 2016). For instance, Coughlin and Stewart (2016) noted that wearable devices have become important technological tools for encouraging physical activity and ameliorating weight gain. Similarly, Naslund *et al.* (2016) argued that wearable devices are recent technological innovations for promoting physical fitness and healthy lifestyle. Schrager *et al.* (2017) studied the efficiency of a wearable device for trailing physical activity on the exercise behaviour and fitness. Their study revealed that there was general improvement in physical activity among overweight adults. Based on the literature, it could be argued that wearable devices are emerging technological-based interventions for stimulating physical activities in order to promote good health.

6.2.3 Sub-theme 3: Daily nutrition and dietary intake

In this sub-theme, participants were asked whether wearable devices help them to monitor their daily nutrition and dietary intake. The majority of the participants expressed that one of their objectives for using wearable devices is to monitor their daily nutrition and dietary intake. They opined that wearable devices had helped them to be more conscious of their daily nutrition and dietary intake. For instance, a participant explained that "being conscious of my daily nutrition and dietary intake has been greatly significant since I purchased the wearable device" (Participant five). Another participant noted that "I try actually to eat healthy and muscle building food and things like that. I have become more conscious of my daily nutrition and my dietary intake and it has been good ever since I purchased it" (Participant six). Also, a participant expressed that:

> *"I have become more conscious because it records those calories that I burn and the food intake. It shows me what I should not take or what I should take in a week. It helps me to understand my nutritional intake'' (Participant four).*

Nevertheless, some participants were not too conscious of their daily nutrition and dietary intake through the use of wearable devices. For instance, a participant stressed that "I have been more conscious about my daily nutrition since I started using the device even though the consciousness is of minor significance" (Participant one). Similarly, a participant expressed that

> *"Ehmm, that's the challenge, that is where I'm having the challenge when it comes to calorie intake, Yes I'm conscious but not that much, I'm still having a challenge on that one, I'm working on it. It has been a minor improvement in term of my daily nutrition and dietary intake" (Participant eight).*

Also, a participant stressed that she was not too conscious of her daily nutrition and dietary intake with the use of her wearable device (Participant nineteen). From these narratives, it can be deduced that those participants agreed that wearable devices had enabled them to monitor their daily nutrition and dietary intake (Al-Azwani, & Aziz, 2016; Casselman *et al*., 2017; Nagtegaal, Verzijl, & Dervojeda, 2015; Jessgroopman, 2014) However, some participants were not too conscious of their daily nutrition and dietary intake through their usage of wearable devices. Implicitly, this is due to their behaviour; it is not the fault of the devices they are using. From the narratives of these participants, nothing could be inferred about the capabilities of the wearable devices in terms of daily nutrition and dietary intake. Also, their narratives suggest that the wearable devices might have that function, but they are not motivated to use that function for sustained health monitoring.

Another interpretation from the above narratives is that the participants suggested that while wearable devices provide recommendation for nutritious food, the motivation of the participant is not good enough to change their intention to eat healthily. The participants argued that the devices only made them conscious of what they ate, but not necessarily changed their eating patterns. This interpretation of the participants' views is understandable, given the fact that people have become addicted to unhealthy foods, and this habit might be difficult to change. This argument is supported by the existing literature (Poti *et al*., 2014; Patterson *et al*., 2012). This agrees with the theory of planned behaviour developed by Ajzen (1991). When applied to the current study, the wearable device does not provide its users with the needed behavioural control over their dietary and nutritional intake (Gauld, Lewis, & White, 2014; Baker, &White, 2010; Ajzen, 1991).

Based on the above field data, it is found that while most participants expressed that their wearable devices had helped them in monitoring their nutrition and dietary intake on a daily basis, some participants opined that their wearable devices had not been so significant so as to change their bad habits.

6.2.4 Sub-theme 4: Sleeping patterns

Sleep is essential for sound health. Sleep pattern is the extent or variation in sleeping. Some people sleep once per day (biphasic); while others sleep at intervals (polyphasic) (Smith, 2017). Some studies revealed that wearable devices are fundamental for monitoring sleeping patterns in order to achieve sustained health monitoring (Clinical Trials, 2016; Allen, & Christie, 2016). The majority of the participants confirmed that wearable devices are essential to monitoring sleeping patterns. As emphasised by a male participant aged 26 to 35, he used a wearable device to monitor his sleep patterns in order to control his weight (Participant eleven). Another participant stressed that "it tells me when I'm sleeping and when I wake up" (Participant fourteen). While commenting on the importance of wearable devices in health monitoring, a participant noted that "I essentially used it to monitor my sleeping pattern" (Participant fifteen). Furthermore, a male participant aged 26 to 35 stated that "I'm also using my device to track my sleeping pattern. How was my sleep over the last period? Its shows the graph of my sleeping patterns" (Participant sixteen). A few participants mentioned that they did not use the wearable devices to know about sleep patterns. They expressed that they only used the devices to monitor their physical activity.

From the above field data, it is explicit that wearable devices help in monitoring sleeping patterns. This finding is in tandem with the existing literature which confirmed the use of wearable devices for monitoring sleeping patterns (Clinical Trials, 2016; Allen, & Christie, 2016; Kaewkannate, & Kim, 2016; Riverview Health, 2015; Swan, 2012). For instance, Kaewkannate, and Kim (2016) found that most wearable devices provide users with a personalised insight into their sleeping patterns.

6.2.5 Sub-theme 5: Monitoring stress levels

Torres and Nowson (2007) describe stress as "the generalised, non-specific response of the body to any factor that overwhelms, or threatens to overwhelm the body's compensatory abilities to maintain homeostasis or stability" (p. 1). Wearable devices help to measure stress level indirectly through monitoring exercise behaviour and fitness of overweight adults (Montgomery *et al.*, 2016; Linz *et al.*, 2007). In order to understand the perspectives of the participants on whether wearable devices can enable them to be more conscious of the management of their stress levels, participants were asked questions relating to wearable devices and stress levels. Eleven out of the twenty participants noted that wearable devices had helped them to manage their stress levels. For instance, participant seven stressed that she was more conscious of her stress level now because she could monitor her stress levels through her heart rate signs, which could be ascertained through wearable devices. Also, participant four emphasised that his wearable device had enabled him to be more conscious of his stress level to a certain degree. Also, a participant stressed that:

> *"Yes, I have become more conscious of my stress level since I started using the device because I believe running, walking reduces the stress level. Because comparing myself, there was something that happened. We were 5 and it was a stressful situation but when I compared myself to the other 5, I found out that they are stressful, some of them even went to the Doctor, but to me it was a different case. I even suggested to them that sometimes you don't need a doctor, you need to just go and run. So I recommended the wearable device to them and some of them are using it now and it is helping them" (Participant eight).*

In a relatively similar sentiment, a participant said that he had not used it to manage his stress levels. He noted that he only uses his device to monitor the stress of running, and for that it has been so significant. He expressed that:

“I have not used it for management of stress level. I have not linked my device with stress. What I could say is I have linked the stress with running. Let say I was running. Let say if I’m stressed and I have been working for the day here since morning and go for a run, my stress level will decrease. The extent of my stress level management has been significant” (Participant one).

From the above narratives, it could be gleaned that the participants expressed that wearable devices help them in monitoring their stress levels. Existing literature suggests that wearable devices can be used to monitor stress levels for overweight adults (Schrager *et al*., 2017; Montgomery *et al*., 2016; Al-Azwani, & Aziz, 2016; Linz *et al*., 2007). These scholars found that wearable devices help in stress management by monitoring exercise behaviour and fitness of overweight adults. As noted by Montgomery *et al.* (2016), wearable devices built by Fitbit have the capacity to send warnings of increasing stress levels to their users. In their study, Al-Azwani and Aziz (2016) found that wearable devices are used as health trackers to monitor stress levels. This also agreed with the expectation-confirmation model adopted in this study (Susanto *et al*., 2016). The authors identified that users’ confirmation after the original use of IS had a positive influence on user satisfaction and, in turn, motivated users’ continuance intention. Thus, satisfaction was projected mainly by confirmation.

However, some participants were of the view that their wearable devices were inefficient in managing their stress levels. Also, some participants opined that their wearable devices did not have functions where they could manage their stress levels. It should be noted that some wearable devices do not have these functions. Also, some users of wearable devices are not aware of the functions and how those functions can help indirectly in monitoring their stress levels. Moreover, it is possible that some people might not be able to afford wearable devices that have functions that can indirectly monitor stress levels. For instance, a participant viewed that “No, because the stress level is still the same immaterial of what activity or the wearable device I’m wearing, the stress stays the same, so I’m not more conscious of the management of my stress levels” (Participant five). Another participant stressed that “management of my stress level that one cannot go. My stress level is high. The wearable device does not have any significant impact on my stress level. No significance at all” (Participant ten).

Based on these results, the researcher posited that wearable devices should provide meaningful recommendations/suggestions that would help the users to regulate their stress levels. When the stress level is high, wearable devices should suggest what they should do to bring it down to a manageable level. This is in agreement with the theory of planned behaviour (Herrmann, & Kim, 2017; Hassandra, Heikkinen, Kettunen, & Lintunen, 2016; Javadi, Kadkhodaee, Yaghoubi, Maroufi, & Shams, 2013). As applied in this current study, the wearable devices give the users the awareness of their stress levels, but they do not provide the users with solutions that would control their stress levels. They are just being aware of their stress levels, but they cannot do anything about them. They are not in control of the outcomes. It is found that while some participants argued that their wearable devices had helped them in the management of stress levels, some participants expressed that their wearable devices were not efficient in the management of stress levels. Also, some participants noted that their wearable devices did not have functions that they could use in the management of their stress levels. Thus, it is arguable that the management of stress levels through the use of wearable devices depends on the quality of wearable devices that participants are using. It also depends on the purposes for which each participant purchased their respective wearable devices.

6.2.6 Sub-theme 6: Detection of early illnesses

Some studies have indicated that wearable devices could be used to detect early symptoms of illnesses (Ajami, &Teimouri, 2015; Patel *et al.*, 2012). Participants were asked whether wearable devices could help them to detect early symptoms of illnesses. While responding to this question, nine participants mentioned that the devices did not detect early symptoms of disorders. For instance, a participant stressed that "my devices did not do that" (Participant one). Similarly, another participant stressed that her own device did not perform that functionality. She, however, expressed that she would like to get a wearable device that would help her detect early symptoms of sickness (Participant three). Also, another participant was emphatic when she said that "my device does not detect any forms of symptoms" (Participant eighteen). Participant thirteen noted that she could not say whether her own device could do that because she had not even tried it on her wearable device. This implies that the wearable devices do not completely give their users the ability to control their health conditions. This also agrees with the theory of planned behaviour (Herrmann, & Kim, 2017; Hassandra *et al.*, 2016; Javadi et *al.*, 2013). Applying this theory to the use of wearable devices among the overweight adults implies that the wearable devices do not give their users perceived behavioural control over their health conditions. This is because, as noted by five participants, some wearable devices do not have functions for detecting early symptoms of disorders.

However, eleven participants argued that their wearable devices had helped them in detecting early symptoms of disorders. Their position is that wearable devices could be used to detect early symptoms of disorders through the monitoring of heart rate and stress levels. From heart rate and stress levels, one can detect some symptoms of disorders. For instance, a participant stressed that "Well! The heart rate monitor can do that, but I don't use it" (Participant six). In addition, a participant expressed that "yes, I will say so especially when you have an advanced wearable device like the one that checks heart rate and all of those things; so obviously you will know the rhythm and pulse of your heart. Then if it is something that is not fine, the wearable device will help you" (Participant twelve). Another participant expressed that:

> *"Yes, it does because when I check my high blood pressure which also links to my heart beat also so if the heart beat reaches a certain point then I can actually approach a clinic or a doctor to enquire about such. So it is beneficiary and helpful for early symptoms relating to heart problems and blood pressure" (Participant fifteenth).*

In the same vein, a participant expressed that:

> *"Yes it does. Because of the FLO App that I linked my wearable device to. I do log in symptoms that I feel and then it also gives me a prompt on my Fitbit that in a few days your menstrual circle could possibly start. Because of that I will probably be experiencing symptoms such as cramps or diarrhoea" (Participant seventeenth).*

Existing studies showed that wearable devices could be used for detecting early symptoms of disorders (Ajami, &Teimouri, 2015; Patel *et al*., 2012; Klasnja, & Pratt, 2012; McCann *et al*., 2009; Kearney *et al*., 2009; Weaver *et al*., 2007). Ajami and Teimouri (2015) noted that there is an increased usage of wearable devices to detect health disorders and status of patients in order to know the required medical interventions. Patel *et al*. (2012) suggested that the use of wearable devices had been found to be helpful in the detection of early symptoms of severe illness. The use of wearable devices to detect early symptoms of severe illness is important in order to put in place the necessary preventive mechanisms (Klasnja, & Pratt, 2012). Also, the study of McCann *et al*., (2009) revealed that patients used wearable devices to monitor early symptoms of illness. This also agrees with the expectation-confirmation model adopted in this study (Jafari *et al*., 2017; Jiang, & Klein, 2009). Jafari *et al*. (2017) reported that the most powerful reason for perceived enjoyment is confirmation, the most influential factor of usefulness is confirmation. Thus, confirmation has a lasting influence on the behavioural intention of overweight adults to use wearable devices for self-monitoring. Jiang and Klein (2009) affirmed that if a product meets expectations, it will lead to satisfaction and if a product falls short of expectations, it will lead to disconfirmation, and the user may likely be dissatisfied.

Based on the above field data, it is evident that while some participants argued that wearable devices could not help in detecting early symptoms of disorders, other participants were of the view that wearable devices could be used to detect early symptoms of disorders as a result of their capacity to measure heart rates, stress levels and sleep patterns. Also, some narratives of the participants showed that while some wearable devices have functions that could be used to detect early symptoms of disorders, others do not. From these later narratives, it can be argued that the use of wearable devices in detecting early symptoms of disorders depends on the quality of the devices that the users purchased for that purpose.

6.2.7 Sub-theme 7: Medication adherence

As noted by Kalantarian *et al.* (2015), wearable devices enable their users in medications adherence. When participants were asked whether the wearable devices they were using are capable of improving medication adherence, seven out of the twenty participants were of the view that some of them (wearable devices) did. For instance, a participant responded that “yes, it can if I have the right one. It can help because I know there are devices that can actually remind you that it is time to take this, it is time to do this. I think it will be of great help. It will just be like us setting an alarm for us to do some certain thing. It will actually be of great help” (Participant ten). Also, a participant expressed that “yes, because I’m able to set a reminder using my devices to remind me of the actual time to take my medication. It has increased and improved my medication intake adherence (Participant sixteen). In the same vein, a participant expressed that:

"Yes, I think so because you will be able to take the records on your wearable device and show your doctor. I have actually done some specific activities like running and walking. Because it keeps the history of your daily activities, it is capable of improving medication adherence" (Participant twelve).

The above narratives are supported by existing literature on wearable devices and medication adherence. For instance, Kalantarian *et al*.'s (2015) study revealed that devices aided adherence to medications' prescription. Also, Kalantarian *et al*.'s (2016) study indicated that wearable devices enhance medication adherence for the overweight adults. In addition, the findings of Sideris *et al*. (2015) explained that wearable devices had remote health monitoring system features that offered automatic messages to encourage users to adhere to the prescription routine. Wearable devices encourage, enhance and increase patients' levels of adherence; lessening the incidence of severe illness among the adult population (Sideris *et al*., 2015). Similarly, Krishna *et al*.'s (2009) study showed that there were major improvements in patient's adherence to medical treatment with the use of wearable devices.

However, thirteen participants expressed that wearable devices they were using could not be used for ensuring adherence to medication. For instance, a participant expressed that "not this one because my device does not support the function. My wearable device is not capable of monitoring medication adherence, not this one because my device does not support the function" (Participant two). Another participant viewed that "not mine, mine does not perform that functionality" (Participant three). Moreover, a participant expressed that "no, my device does not support that functionality" (Participant seven). In addition, a participant expressed that "no I have not come up with that one" (Participant eight). Also, a participant narrated that "no, my device does not support medication adherence" (Participant fifteen). Also, a participant expressed that:

"Mine does not support the functionality, but I think it can if the device is sharing information with something. I know Discovery Health has an option that has a health plan where, if you got a wearable device that uploaded into the health plan, the doctor can actually see the next time you go for the doctor's visit. The doctor can actually see your activity levels; basically it will be showing as a graph or something like that. There is that

actual functionality available, but again you need to have a medical aid you need to have the right kind of wearable device" (Participant nine).

Based on the above field data, although seven participants expressed that their wearable devices could be used to ensure adherence to medications, other participants stated that their wearable devices did not have functions that could enable them to achieve the objective of adherence to medication. Implicitly, it can be argued that the majority of the participants believed that wearable devices could be used to ensure adherence to medications even though some participants expressed that their own devices did not have that function. But, it should be emphasised that the position of most of the participants was that wearable devices could help in ensuring adherence to medication because they had functions which could be set to remind them of the time they need to take medications as prescribed by medical practitioners. This empirical position agrees with exiting literature on the usage of wearable devices for ensuring adherence to medication (Kalantarian *et al*., 2016; Kalantarian *et al*., 2015; Sideris *et al*., 2015; Krishna *et al*., 2009). This is also in agreement with the expectation-confirmation model adopted in this study (Kalantarian *et al*., 2015; Sideris *et al*., 2015).

6.3 Theme 2: Perceived Usefulness of Wearable Devices for Sustained Health Monitoring

In order to know whether wearable devices improve sustained health monitoring of overweight adults, participants were asked whether wearable devices enable them to have better control of their health conditions in order to ensure sustained health monitoring. In responding to this question, ten out of the twenty participants noted that wearable devices allow them to achieve their objective of weight loss through physical activities. They (participants) argued that they used their wearable devices to prevent an increase in weight, and by implication, obesity. For instance, a male participant stated that "I usually look at how many calories I have lost because my reasons for running is to lose weight and when it tells me that I have lost so many calories, it motivates me" (Participant One). The participant added that:

"My weight loss has increased since I started using it. For example, if I work out consistently, because if I work out consistently, I lose the weight, but there are times I suddenly stop like for a month or two then pick up on it again. I have experienced a significant improvement in my daily activity and weight loss program" (Participant one).

This implies that these participants perceived wearable devices to be effective in ensuring that their users have relative control over their weight. This agrees with the finding of Pfeiffer *et al.* (2016) on perceived usefulness of wearable devices among overweight adults. Their study revealed that perceived usefulness is considered as the perceived probability that a wearable device will enhance overweight adults in attaining goals concomitant with the usage of such devices. It is predicted that overweight adults have a particular objective in mind before embarking on the usage of wearable devices (Pfeiffer *et al*., 2016). Hamid *et al.* (2016) postulated that perceived usefulness is a relevant factor in forecasting usage intention and it is anticipated that it will define overweight adults' behaviour towards using the wearable devices in their efforts to improve their health status.

Also, a female participant aged between 26 and 30 expressed that "I look at the steps that I have taken and the calories that I have burnt … my weight loss has increased because I have lost weight because when I started I was weighing more than what I'm weighing now" (Participant twelve). Another participant noted that "well my weight loss has increased compared to 106kg when I started using the device. I now weigh 102kg. The device has been of greater significance to my daily physical activities and weight loss" (Participant twenty). This further revealed the perceived usefulness of wearable devices for sustained health monitoring among the overweight adult (He *et al*., 2017; Chuah *et al*., 2016; Buchwald *et al*., 2015; He *et al*., 2017; Gallant *et al*., 2006). For instance, Chuah *et al.* (2016) reported that perceived usefulness has a strong influence on the attitude of overweight adults toward using wearable devices. He *et al*. (2017) found that perceived usefulness of wearable devices determine both the intention to use and the intention to repurchase wearable devices. According to Gallant *et al*. (2006) perceived usefulness is the main reason that makes users decide to use and accept new IS products.

However, three participants stressed that they do not use wearable devices to monitor their health or regulate their weight levels. For instance, a female participant stressed that: "I don't ever check my calories I don't even know why, I don't even know how they work. I don't check my calories" (Participant thirteen). This participant might not know that wearable devices could be used to monitor calories burnt or taken in. Since this participant does not know that wearable devices can do this, it cannot be said that it would influence her intention on the use of wearable devices for monitoring calories burnt and taken in. The intervention in this regard is that there is the need for adequate sensitisation of the users of wearable devices on different functionalities of wearable devices.

Also, a participant expressed that the device that she was using did not have functions that she could use to measure the number of calories she had lost. She was thinking of getting another one that would afford her the opportunities to calculate the level of calories she had lost. According to her, “I don’t use it for health monitoring, mine is very simple I don’t even like it. I should actually, when I get another one, I want to invest in a better one that will give me all that information” (Participant seven). This implies that this participant implicitly emphasised that cost is the major factor that makes her wearable devices less useful in terms of monitoring calorie intake. This agrees with the existing literature (Casselman *et al*., 2017; Al-Azwani and Aziz, 2016; Nagtegaal, Verzijl, & Dervojeda, 2015; Jessgroopman, 2014). Al-Azwani and Aziz’s study (2016) found that cost remains a major bottleneck to an average user of wearable devices. Also, the study of Jessgroopman (2014) showed that 55% of the respondents indicated that wearable devices were too costly to acquire. Presently, manufacturers are besieged with their inability to balance the cost of wearable devices with their added value to consumers (Jessgroopman, 2014).

Also, seven of the participants expressed that wearable devices had not been that effective in ensuring that they had control over their health conditions. They opined that their objective of controlling their weight had not been fully achieved with the wearable devices they were using. For instance, a female participant lamented that her weight loss has not increased. She complained that her wearable device only measured her daily activities. She expressed that “not really in terms of my weight loss because I don’t feel any difference in my weight. Though it has been effective in terms of my daily activities monitoring” (Participant seventeen). From these opposing narratives, it could be gleaned that the objective of some of the participants for using wearable devices was not actually to reduce weight, but just to monitor their daily activities for sustained health monitoring; while some mentioned that they just wanted to keep their body shape. It could be deduced from these interpretations that the participants had divergent reasons for using wearable devices. Put it differently, not all participants were using wearable devices to achieve weight loss.

From the above presentation and discussion, the following key findings were derived:

- Wearable devices can be used to achieve the objective of weight loss
- Wearable can be used to enhance daily activities
- Wearable devices are useful in monitoring of calories

6.4 Theme 3: Satisfaction with Wearable Devices for Sustained Health Monitoring

To know the level of satisfaction of the participants on their usage of wearable devices for sustained health monitoring, participants were asked questions on the frequency of the usage of wearable devices and user-friendliness of the wearable devices for sustained health monitoring. In order to capture these two aspects of this theme, this section is divided into two sub-themes.

6.4.1 Sub-theme 1: Frequent usage of wearable devices

Eleven out of the twenty participants implied that they were satisfied as they emphasised that their usage of wearable devices for sustained health monitoring had increased remarkably. For instance, a male participant stressed that "the use of the device has increased because it is still so very functional and still provides the values I needed it to provide" (Participant four). Similarly, participant three stated that "the use of the device increased since I started using it. To me, it is like a medication I can't go on without it. If for some reasons I didn't charge it and it dies on me half a day then I can't function fully without it for that day so it has increased tremendously" (Participant three). In addition, a participant explained that "The usage of the device has increased. For me, it helps me to monitor my progress in the training that I'm doing. So, the more I use it, the more I'm able to track how my progress is basically" (Participant twelve). Another participant mentioned that "the use of the device has increased since I started using it because I wear it and also monitor my health status with it every day". (Participant eighteen). Likewise, participant five explained that:

> *"The use has increased since I got the device; the improvement has been so significant since I purchased it. It makes me work harder towards that activity because you set your goals and you want to reach your goals. Also, I can compare my previous activities with recent activities with the device; so the use has increased"*.

From the above narratives of the participants, it could be deduced the purposes which wearable devices served to their users might have enhanced the behavioural intention of the participants to frequently use the wearable devices for sustained health monitoring. This interpretation of the narratives of the participants agrees with the expectation-confirmation model adopted in this study (Wang *et al.*, 2016; Patricks *et al.*, 2016; Lee *et al*., 2015; Lai *et al*., 2014; Sharmin, 2012; Angelova, & Zekiri, 2011). For instance, Patricks *et al.* (2016) implied that user satisfaction is the expressive behaviour towards a certain IS product by an end user; thus increasing the frequency of wearable devices. Similarly, the study of Lee *et al.* (2015) indicated that behavioural intention to frequently use wearable devices is determined by the level of users' satisfaction with them. Also, Chung *et al.* (2016) confirmed that users' repurchase intentions are highly reliant on the earlier satisfaction of the product, whereas satisfaction is achieved from the expectation of products.

Nevertheless, three participants had different perspectives on frequent usage of wearable devices for sustained health monitoring. For instance, participant sixteen argued that the he was thinking of getting another wearable device because the one he was currently using had not really met his expectations. This equally implies that if the functionality of the device had met the expectation of the user, it was more likely to increase the usage of the wearable devices. Also, a participant opined that she had frequently used it in the previous year when she had had a target to meet the bonus from Discovery Vitality. She mentioned that she was relaxing for now even though she had not accomplished her target. She, however, said that she would start using it frequently again later this year because she had still to meet her target (participant ten). Similarly, a female participant argued that she could not really say its usage had increased or decreased for her because she had just been using it, not monitoring changes. So, she was sceptical whether its usage had increased or not (Participant thirteen). From the above nuances, it could be inferred that these participants still believed that wearable devices served their purposes for which they had purchased them and they demonstrated intentions to increase their (wearable devices) usage for sustained health monitoring.

However, six participants stated that their usage of wearable devices for sustained health monitoring had decreased. For instance, participant twenty stated that he had just purchased a new phone, and he spent more time working with his phone than using his wearable device. He said thus: "the use of the device has decreased lately because I recently purchase a new phone and I spend more time going through the phone". This narrative does not imply that the participant does not want to increase his usage of wearable device for sustained health monitoring. His narrative suggested that he was preoccupied with something unrelated to the usage of wearable device for sustained health monitoring. Also, participant nine was critical of his usage as he expressed that:

> *"I think when I first purchased it I was about more keen to put stuff on the app and everything but the fact that you manually put it on to the app became a little bit annoying and the device was not automatically doing everything another high end wearable devices can do that they can record a lot more unto the app but this is a low end wearable device. So it has very limited features. I usually use Bluetooth to synchronise it but it does not sync to the app any more so that is the problem. I will actually say the use has decreased because I don't use it as much as I probably could".*

From the narrative of the participant nine, it is deduced that he was frustrated by the type of wearable device he was using for sustained health monitoring. Implicitly, he was stressing that he needed to get another wearable device that would have everything he needed. This also implies the issue of cost. The participant might have not been able to get a more functional wearable device because of the cost. According to Naslund *et al.* (2016), cost of the wearable devices is one of the major impediments to frequent usage of wearable devices for sustained health monitoring, particularly among the low-income users. Also, Casselman *et al.* (2017) found that high prices of procuring wearable devices had been one of the major inhibiting factors to increased usage of wearable devices for sustained health monitoring.

6.4.2 Sub-theme 2: User-friendliness of the wearable devices

To further buttress how satisfied the participants were with the wearable devices they had been using for sustained health monitoring, the researcher asked the participants whether the wearable devices they were using were user-friendly. Eighteen out of the twenty participants expressed that the wearable devices they were using were user-friendly. They mentioned that the wearable devices they were using for sustained health monitoring were easy to use. This suggests that they were satisfied with their wearable devices. For instance, participant one stated that "it is easy to use because no one taught me how to use it but I found out when I wanted to use. I have explored it as well as look around it, it is easy to find, it is easy to use it" (Participant one). This agrees with the existing literature on the user-friendliness of the wearable devices. For instance, Sonderegger *et al.* (2015) reported that designing wearable devices in such a way that they can be easily used by their users determines the behavioural intention of the users to increase usage. Also, Lee's (2010) study implied that user's frequent usage of wearable devices are positively influenced by their user-friendliness.

Also, a participant mentioned that "it is easy to use and has intuitiveness" (Participant nineteen). Moreover, another participant asserted that "my wearable device can be easily used by anyone without stress. It is just like a normal wrist watch that needs no further explanation on how it is being used" (Participant twenty). This agrees with the literature on the user-friendliness of wearable devices (Haug, 2018; Liu *et al*., 2016; Hwang *et al*., 2016; Mumcu *et al*., 2015; Sonderegger *et al*., 2015; Lee, 2010; Liu *et al*., 2010; Crilly *et al.*, 2004; Norman, & Ortony 2003). Hwang *et al.* (2016) emphasised that the aesthetic attributes of wearable devices make them more user-friendly because those aesthetic attributes enhanced their attractiveness.

In addition, a participant stressed that their devices are "very easy to use. A device gives you the menus and the options that you can set so it is actually easy; if you are computer savvy, it should not be difficult to use the devices. Though I have not tried other devices just the Garmin" (Participant six). Similarly, a participant argued that "definitely it is user-friendly because you put it on and you go on with your activities. Though I have not tried other devices, I would like to, but I have to get another one and a bigger one, but it is very expensive" (Participant seven). Based on the above narratives, these participants emphasised that their wearable devices were easy to use even though they had not tried other wearable devices. According to them, the reason they had not tried other wearable devices was that they could not afford the prices of other wearable devices. This finding is supported by Casselman *et al.* (2017) and Naslund *et al.* (2016), who found cost an inhibitive factor to the usage of wearable devices.

However, four out of the twenty participants were critical of the user-friendliness of wearable devices. For instance, participant nine was critical of the user-friendliness of wearable devices. It should be mentioned that the participant expressed his view in terms of Fitbit (entry level model). He argued that they are user-friendly but in term of practicality, one has to connect to the App. So, as he said, connection to the App makes it a little bit complex to use. Another participant, who is using Huawei TalkBand B3, stressed that connection to the App made it a little bit complex to use, especially for non-technology savvy folk (Participant fifteen). From these two narratives, it could be gleaned that only two participants who were using Solace and Huawei TalkBand B3 complained that their wearable devices were not user-friendly.

6.5 Theme 4: Continuance Usage of Wearable Devices for Sustained Health Monitoring

On the issue of continuance usage of wearable devices, the participants were asked whether they would continue the usage of their wearable devices. Fourteen out of the twenty participants responded that they would continue using their wearable devices because they were still serving the purposes for which the devices had been purchased. For instance, a participant said he would continue its usage "because sometimes if I'm running without it, I will feel that I'm missing a lot" (Participant one). Another participant emphasised that "I do intend to continue using it, and actually like to get a new one because there is a new one my aunty has. It just looks nice" (Participant two). This implies that the participant intended to continue using wearable devices for health monitoring. Participant eight mentioned that:

> *"Yes very, because it is helping me and it is even helping others now. I'm even recommending it to others because for me it is helping me for stress levels management, monitoring of steps taken per day, weeks and months, and also for my health purposes".*

Also, a participant viewed that "yes, for everything because I need to measure my progress. It helps me to track and monitor my activities and know my progress whether I'm better in my lifestyle or not. I will continue to use my devices every day because I want to know that today I'm doing better than I did yesterday; that is what I'm tracking" (Participant thirteen). Another participant submitted that "yes, I will actually continue using the device for health monitoring because for me it has actually helped. Since it has actually helped me, I will recommend it to anyone else who has the same or similar goals that I have" (Participant fifteen). Another participant said "yes, I can't stop using it because the device has benefitted me a lot and I have witnessed major improvements in my health" (Participant twenty). Furthermore, a participant said:

> *"Yes, I will continue using wearable devices for my health monitoring especially my heart rate. Because I found out if you are breathing, let us say your fitness is proportional to your heart rate because if you are running uphill and you are struggling to breathe so your heart rate is too high, it means you are not fit enough in my view and you are not quick*

enough running up that hill, but as soon as your heart rate stabilises that is when you run the fastest" (Participant fourteen).

From the above narratives of the participants on the continuous usage of wearable devices for sustained health monitoring, it is explicit that the behavioural intention of the participants to continue using wearable devices was high. The majority of the participants revealed their behavioural intention to continue the usage of wearable devices for sustained health monitoring because of the perceived usefulness of wearable devices in terms of health monitoring such as monitoring physical activities, sleep patterns, health rate, nutrition and dietary intake, adherence to medication among others. The decision of these participants to continue to use wearable devices might have been informed by the fact that they were satisfied with the wearable devices they had been using for sustained health monitoring. This agrees with the expectation-confirmation model adopted in this study (Weng *et al*., 2017; Luqman *et al.*, 2014; Zhao *et al*., 2013; Jin *et al*., 2010; Bhattacherjee, 2001b). For instance, Bhattacherjee (2001b) proposed users of wearable devices have a tendency to use them incessantly when they are satisfied with initial experiences of usage. Also, empirical evidence of Liu (2014) on IS continuance revealed that users' satisfaction is a major factor of IS continuance intention. Similarly, Assensoh-Kodua and Lekhanya's (2014) study revealed that continuance intention is determined by satisfaction and perceived usefulness of continued IS use.

While the majority of the participants felt satisfied with the wearable devices they were using, three participants stressed that they would like to get other wearable devices because they were not really satisfied with the one they had currently been using for sustained health monitoring. However, they were handicapped by the high prices of obtaining wearable devices they thought they actually needed for their sustained health monitoring. For instance, a participant noted that he would like to get another one. This implies that the participant wanted to upgrade to another one that would serve him better - the one that would have more functions than the one he was currently using. This equally means he intended to continue the usage of wearable device. He narrated thus:

"I actually want to upgrade the device I'm using at the moment. There is a new device that I want but just a little out of my price range at the moment. It is just under R3000 rand. So I definitely will upgrade when I have the money. I just don't have the money to … I could

have gotten another cheap one, but then it pretty much does similar functions to this current wearable device" (Participant nine).

Similarly, another participant mentioned that she would get another one when she had money. She said as time went on, she would need another one that had more functions and was more effective than the one she was currently using. This also implies that the participant wanted to continue the use of wearable device to monitor her health; she just wanted to get another wearable device that would be more effective. She narrated that:

"Yes, I do because I intend to keep a healthy lifestyle. When I GET MONEY I will buy another one because I'm also a Discovery Vitality member, so with Vitality when you have these wearable devices you earn points and you get to collect some nice incentives for keeping healthy" (Participant twelve).

From the above two narratives, it is explicit that the participants had mentioned the prices of wearable devices as the impediment to the procurement of wearable devices they actually wanted for sustained health monitoring. It can be argued that cost is one of the major factors that could limit the continuous usage of wearable devices, especially among the low-income users of wearable devices (Naslund *et al*., 2016; Casselman *et al*. 2017). Based on this empirical position, it can be inferred that cost is one of the factors that could inhibit the behavioural intention of the users of wearable devices.

However, only three participants posited that they would not continue the usage of wearable devices. For instance, participant nineteen stated that she would stop using her wearable device because of the hectic matter of charging it every time. She said charging all the time could be so frustrating to her. She also mentioned that it felt too bulky to carry around all the time. Also, she opined that sometimes it might not match with her outfit. So, as she said, she would not wear that day. She said thus: "No, it is too much work to remember to charge it all the time. Depending on my mood, I don't like wearing it as it is bulky and doesn't fit with my outfit" (Participant nineteen). From the reasons she gave, the researcher posited that she could get another one that could last longer without charging and would be less heavy to carry around.

6.5.1 Sub-theme1: Physical security and information security

A female participant expressed that she was not worried about sharing information while using wearable devices. What really concerned her was the fact that she was scared of being robbed while running with a wearable device worth about R5000. She mentioned that some areas where she ran were not safe. So, her concern was the fear of being robbed, not the fear of sharing her information with the public (participant seven). Also, participant five echoed the same sentiment when she said that "I have never worried about security or privacy. Because I do not link it to anywhere. It's just linked to my phone. The only thing I'm worried about is getting robbed when I run with it" (Participant five). Two interpretations could be derived from the narrative of participant five. First, the participant implied that she was not worried about privacy and security concerns because she could control access to her vital signs. Second, she was only worried about being robbed. Fear of being robbed is understandable if the users are residing in socio-economically disadvantaged neighbourhoods.

From the presentation and discussion in this section, the key findings are summarised below:

- It was found that the users had the intention to continue using wearable devices for sustained health monitoring.
- It was found that frequent charging and short battery life of wearable devices is an inhibitive factor to continuance usage of wearable devices
- It was found that prices for upgrading are a factor that could discourage the continuance usage of wearable devices.
- It was found that the fear of being robbed could discourage the continuance usage of wearable devices.
- It was found that the bulkiness of some wearable devices could inhibit the continuance usage of wearable devices.

6.6 Theme 5: Privacy Concerns of Wearable Devices by Users

As noted by Herring (2016), privacy is the ability of a person to conceal his/her vital information. In the context of this study, privacy setting is used as a means to conceal vital information of the users of wearable devices. The narratives of the participants on privacy concerns are rich and nuanced. In order to capture the richness and nuances of the participants' narratives in this regard, this theme is divided into a number of sub-themes. These are presented below:

6.6.1 Sub-theme 1: Privacy and how it affects the intention to continue usage

Participant twenty also raised serious privacy concerns with the use of wearable devices. The participant stressed that he feared that his vital signs information might be leaked to unauthorised parties. This agreed with findings of Salah *et al.* (2014), Al-Azwani, & Aziz (2016) and Spann (2016). For instance, Salah *et al.* (2014) found that users of wearable devices were more concerned about their health information. Also, Spann (2016) reported that the users of wearable devices feared that their vital information might fall into the wrong hands. When the participant was asked whether this could hinder his behavioural intention to continue using wearable devices for sustained health monitoring, the participant noted that "it can hinder my continuous use of the device because I will stop the usage of the device once I notice any form of infringements on my personal information stored on the device". He added that he might not advise other people to use wearable devices for sustained health monitoring because their medication and health information might be easily tampered with by unauthorised persons (Participant twenty).

It could be surmised that this participant had a very serious privacy concern. He considered his security and privacy more important than the perceived usefulness of the wearable devices. It could be deduced that privacy issues could negatively affect the behavioural intention of some users of wearable devices. This agrees with the finding of Fiercebiotech (2014) which indicated that privacy concerns are a major impediment hindering the continuous use of wearable devices among some individuals. Also Piwek *et al.* (2016) argued that sharing vital signs of the users of wearable devices could more likely increase the probability of identity scams. Grand View Research (2016) submitted that privacy issues are one of the major challenges in wearable devices which are already influencing behavioural intention of users and in the next few years, may affect the growth of wearable technology. Boscart *et al*. (2008) reported that users' insecurity became a significant factor in the continuous usage of the wearable device. The study of Acquisti, Gross and Stutzman (2011) identified privacy and security as part of the five top vital concerns that users considered important in the continuous usage of wearable technology. Furthermore, Sconce (2016) submitted that mistrust of wearable technology by users posed a serious challenge to their behavioural intention as a result of data insecurity (DuFour *et al*., 2016; Gribel *et al*., 2016; Beltrameli, 2015; Popat, & Sharma, 2013; Kumar, & Lee, 2012; Acquisti *et al*., 2011; Boscart *et al*., 2008).

Also, participant sixteen raised privacy concerns during the data collection stage of this study. When the researcher asked further whether the concern for privacy could hinder his continuous usage of wearable device, the participant said it would definitely affect it because it would not be fine if he discovered that someone was having access to what was supposed to be private to him. This agreed with the submission of Al-Azwani and Aziz (2016) when they submitted that the producers of wearable devices gathered data from users' and there were notions that some of these producers were willing to share users' information with third parties. This information sharing would include behaviour, gender, profiles, age, location, social media accounts and email address as well as GPS information. Confidentiality of personal data produced by the users is thus a major issue of wearable devices (Al-Azwani, & Aziz, 2016). As noted by Spann (2016), the users of wearable devices are concerned about sharing their information with the third parties. Salah *et al*., (2014) stressed that privacy and security are of paramount concern, especially with wearable devices that collect health and medical information. The recent privacy fears related to wearable devices are posing a threat to users' continuous intention (Salah, MacIntosh, & Rajakulendran, 2014).

When the participant was probed further if he could still recommend wearable devices to someone despite the privacy concerns he had pointed out, the participant expressed that he could recommend to them if they did not mind if their information about their health would be exposed. The participant opined that he would recommend it to them because of its numerous benefits if they did not mind seeing the information about their health in the public domain. According to the participant:

> *"If they don't mind their privacy loss, because I'm looking at the benefit that they are going to derive. You will notice that sometimes you might have to forgo your privacy if your condition means you have to do it. So it is a matter of weighing up how much you are going to lose and what you are going to gain at the end of the day. So if my benefits are more I*

> *would rather recommend it to other people in as much you going to lose ABC and D in form of privacy lose. Sometimes it's worth it to lose your privacy to be healthy. At the end of the day, inasmuch as the device is taking our health information, we are gaining" (Participant sixteen).*

From the above narrative of participant sixteen, despite the fact that the participant expressed that her behavioural intention to continue using wearable devices for sustained health monitoring would be greatly hampered, she noted that she would still recommend them (wearable devices) to other people if they did not care about sharing their information with the third parties. This narrative of the participant implies that the participant also confirmed the perceived usefulness of wearable devices for sustained health monitoring (He *et al*., 2017; Chuah *et al*., 2016; Buchwald *et al*., 2015; He *et al*., 2017; Gallant *et al*., 2006).

On whether the participants have concerns regarding privacy, a male participant said he was more concerned about privacy. He said that his privacy may be under threat because his movements and activities could be made public (Participant one). This agrees with the study of Mottim and Caine (2015) when they concluded that technological domain is not excluded from privacy concerns, but privacy issues relating to wearable technologies are somewhat new. However, the participant said that the concern for privacy could not hinder him from using the wearable devices because of their benefits to him. According to him, "privacy cannot hinder me from the continuous use of the devices due to the benefit I'm gaining from the usage of the device" (Participant one). This further supported the perceived usefulness as well as confirmation of wearable devices for sustained health monitoring (Pfeiffer *et al*., 2016; Hamid *et al.*, 2016). The studies of these authors indicated that perceived usefulness of wearable devices for sustained health monitoring is one of the key factors determining the behavioural intention of the users of wearable devices, despite their privacy concerns.

When the participant was asked whether he would still recommend the use of wearable devices to someone else despite the privacy issues he had raised, the participant commented that "yes, I will definitely inform anyone I will be recommending wearable devices to of the likely privacy issues they may likely experience and how they can be in control of their device". Similarly, participant four also raised concerns about the lack of privacy. But, he also said that he would still continue the usage of the device and even recommend it to other people because it really served the purposes for which it had been purchased. Also, a male participant stressed that he was more concerned because he did not know where his information went and what it might be used for in the future. He said someone could easily hack the database of the companies that produced wearable devices and retrieve all the information. He feared that his privacy was at stake because somebody could easily use his information against him in the future (Participant seven).

Nonetheless, in the later part of the interview, he stated that "I don't care if anyone can see, maybe they will be motivated to get one to monitor their exercise; I don't think it poses any security threat". This participant felt that when people saw the numerous functions of the device in terms of sustained health monitoring, they might be motivated to get one for themselves too. This also supported the expectation-confirmation model adopted in this study (Schwarz *et al*., 2016; Patricks *et al.*, 2016). The studies of these scholars showed when the users of wearable devices found them efficient or they were satisfied with the devices in monitoring their health, their behavioural intention to continue the usage of the devices for sustained health monitoring would increase. Based on the results above, the privacy concerns cut across all the theoretical constructs of the expectation-confirmation model adopted in this study. Despite the above participants raised privacy concerns, they still emphasised they would continue using wearable devices for sustained health monitoring. This implies that these participants confirmed the perceived usefulness of the wearable devices for sustained health monitoring. It also indicated that they were satisfied with the wearable devices for sustained health monitoring. Because they confirmed the perceived usefulness and expressed their satisfaction with the wearable devices for sustained health monitoring, their behavioural intention to continue using wearable devices had been enhanced.

6.6.2 Sub-theme 2: privacy and control over information

Five out of the twenty participants were not concerned about privacy while using wearable devices because they could control access to their vital signs. For instance, participant two noted that "people can only see my steps for the day or the week. But only I can see my heart rate and my stress levels" (Participant two). This implies that the participant had control over who could have access to her vital signs. This could mean that there is a function in the wearable device where users can control access to their vital signs. Also, a participant stressed that she could control access to her information while using wearable devices. She expressed that "I can block access to my information. So, if I want to link it to my Apps, I can link it and share my activities with other people, but if I don't want to, no one can access it" (Participant eighteen). Participant eighteen added a new perspective to this sub-theme when she expressed that it should be something enjoyable and exciting sharing your information with others to see. The participant said she felt excited sharing her information with other people so that they knew the importance of wearable device in health monitoring. This is an indication that the participant was satisfied with the wearable device for sustained health monitoring. This is in tandem with the expectation-confirmation model adopted in this study (Weng *et al*., 2017; Luqman *et al*., 2014; Zhao *et al*., 2013; Jin *et al*., 2010; Bhattacherjee, 2001b).

Interestingly, participant six explained that there is a function in the wearable devices where you can share information. The participant expressed that you can only make it public if you want to. However, another participant disagreed that the wearable device could share information. He said that it could only share information with a paired App, which meant that users could decide whether they wanted to share information or not. He explained thus:

> *"Not really, because the device does not share information with anything rather than a paired App. You can only pair it with an App to share information and the App I'm using does not share information with anything. So again it is very limited and even if I had more advanced wearable device and I was using let my medical aid system. When I meet with my GP, I'm the one who said fine you can put me onto the program so if I now get an App that can pair, the App will pair with their program and the only one who should have access to that information is my medical practitioner. I'm not really concern about because if I walk around people can see that I'm overweight. So I'm not really worried about people knowing how much I'm weighing now and how high my weight is. The only concern might be discovery might use my detail for something like not allowing me to take certain insurance, something like that, but again, my insurance is with another company and not with Discovery" (Participant nine).*

The above narrative also implies that the users of wearable devices could control access to their vital signs. While the participant stressed that wearable devices do not have in-built functions where the users can control access to information, he noted that they can only be used to share information with a paired App. If the narrative of this participant is correct, the appropriate intervention should be that the makers of wearable devices should upgrade their products so that the users can control access to their vital signs.

Five participants emphasised that they were not concerned about privacy. For instance, participant three noted that she was not even worried about her privacy. She said she would only be worried when something happened to her. According to her, “privacy is not one of my priorities. It is hardly something I even think about”. Also, participant twelve said “what will anyone have to do with my wearable device history?” The participant noted that it is of no use to them. Similarly, participant thirteen stressed that “why would I have privacy concerns? I’m not concerned about sharing my wearable device history with the third parties because who else needs to know about my heart rate and my vital signs if it is not the third parties?”.
Also, a participant expressed that “not really, I don’t think the data it collects is important enough to steal or will invade my privacy” (Participant nineteen). Also, a participant noted that “I don’t feel it’s a private matter. I don’t care if my information is seen by someone else. Honestly I’m not that kind of private person, it is not like it is a secret thing like HIV status. It is just my work out histories, heart beat histories” (Participant fifteen). It can be deduced from the above narratives that the participants argued that their vital signs could not be used against them by the third parties. They (third parties) could only use those vital signs to motivate themselves to also start using wearable devices for sustained health monitoring. Thus, the participants under this sub-theme were not concerned about making her information known to third parties.

Nonetheless, a participant emphasised that she was not so worried about privacy because of the information revolution. She said “I am not worried about privacy because we are in the age where everything is online. I’m sure the security is not a problem” (Participant ten). When the researcher asked whether she would continue the usage of wearable devices for sustained health monitoring even if her vital signs were exposed to the public, she replied that she could not say for then. She said she was still doing her research on the issue of privacy. The result of her research would determine her future action on the continuous usage of wearable devices (Participant ten). Also, a participant stressed that he could decide with whom he wanted to send or share his information.

He said his wearable device had a function where he could share his information to whomever he wanted (Participant fourteen). However, when the researcher pushed further, the participant said it could hinder his continuance usage of wearable devices. He explained how it could hinder him thus:

> *"Yes, it can hinder me because when you are registering for the APP on their website, you put your email addresses there, you get a password, so that has to be protected because remember if someone can go through my emails then everything is linked there, be it my banks and everything else" (Participant fourteen).*

Likewise, participant seventeen expressed that she was concerned about privacy while using wearable devices. However, when the researcher further probed whether the concern for privacy could hinder her continuous usage of wearable devices, the participant said that it would affect her future use of wearable devices because she could not allow third parties to have access to her personal information. She expressed that: "It would hinder me I think because I don't want people to know the number of steps I take per day. I just want to keep it private (Participant seventeen). This agrees with the findings of DuFour *et al*. (2016); Beltrameli (2015) and Boscart *et al*. (2008). These authors found that privacy concerns were fundamental in determining the behavioural intention of the users of wearable devices to continue the usage of the devices for health monitoring.

6.6.3 Summary of privacy concerns

In summary, the narratives on the concerns for privacy in the use of the wearable devices among the overweight adults are nuanced. Some participants were of the view that their information could not be used by the third parties because it was only about their physical activities. They posited that their information about the number of calories burnt, number of steps they took while running and their heart rate were of no use to the third parties. But, some participants disagreed on this. Their main reason for disagreement was based on their information about the number of calories burnt being personal to them. On the other hand, some participants expressed that they had serious security and privacy concerns in the usage of wearable devices for sustained health monitoring.

However, participants under this category are divided as to their continuous usage of wearable devices. While some participants under this category posited that it would hinder their continuous usage because they would be allowing the third parties to have access to their vital signs, other participants under this category commented that it would not hinder their continuous usage of wearable devices because of their benefits. In another twist to the narratives in this regard, some participants said that users could make their vital signs known to the public only if they wanted to because some wearable devices had functions where users could chose if they wanted to share their information or not. Nonetheless, a participant noted that wearable devices could only share information with a paired App, where it was optional.

Based on these narratives, the researcher deduced that some users might not have known that their wearable devices had options where they could chose whether to share their information or not. Also, the researcher implied that some users might not have been using the kind of wearable devices that have options to protect their vital signs (information). Additionally, the researcher inferred that some users might not know that sharing information through wearable devices required paired Apps. Therefore, based on these summations, it could be argued that with constant sensitisation of the users on the different functions that wearable devices have could help in ensuring that they safeguarded their vital signs by using functions for that purpose.

6.7 Framework for Behavioural Intention of Overweight Adults to use Wearable Devices for Sustained Health Monitoring

This section deals with the framework developed for this study. The framework was derived from the Confirmation-Expectation Model and validated and extended by the empirical data and existing literature on the usage of wearable devices for sustained health monitoring. This framework is presented in Figure 6.3.

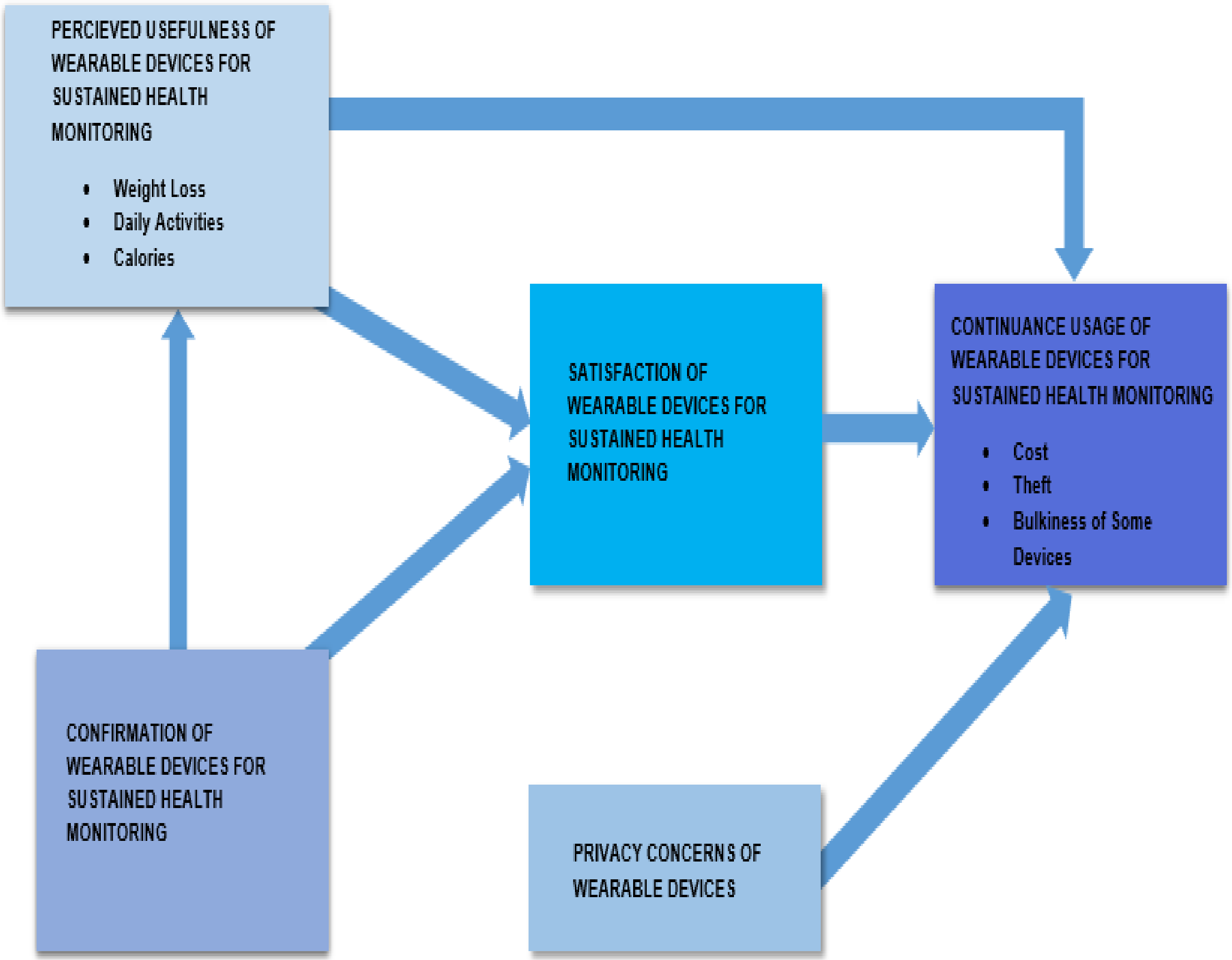


Figure 6.3: Framework for Behavioural Intention of Overweight Adults to Use Wearable Devices for Sustained Health Monitoring

The first construct of this framework which was validated by the empirical data and literature is **'confirmation'**. From the data and literature, wearable devices are confirmed to be effective for sustained health monitoring because they help in monitoring heart rate, physical activity, daily nutrition and dietary intake, sleeping patterns, stress levels, detection of early illness and medication adherence. The second construct that emerged from the framework is **'perceived usefulness'** which was also validated by the empirical data and literature. This construct was a consequence of the 'confirmation' construct. From the 'confirmation' construct, it was found that wearable devices are confirmed to be useful for sustained health monitoring among the overweight adults. This implies that wearable devices are perceived to be useful for sustained health monitoring. Wearable devices are perceived to be useful because they help in monitoring weight loss, daily activities and calories. The third construct is **'satisfaction'**. Since wearable devices were 'confirmed' and 'perceived' to be useful for sustained health monitoring, it implies that the users of wearable devices are satisfied with the wearable devices for sustained health monitoring. The frequent usage and user-friendliness of wearable devices as demonstrated by the participants (users) revealed their level of satisfaction with the devices for sustained health monitoring.

The fourth construct is **'continuance usage of wearable devices'**. From constructs two and three, it was found that the users of wearable devices found them to be useful and, consequently, they are satisfied with them for sustained health monitoring. Based on this, users demonstrated the behavioural intention to continue the usage of wearable devices for sustained health monitoring. However, **cost of obtaining wearable devices**, **likelihood of theft of wearable devices** especially in socio-economically disadvantaged neighbourhoods, **frequent charging and short battery life of wearable devices and bulkiness of some wearable devices** are inhibitive factors to continuance usage of wearable devices. Another critical construct that could hinder the behavioural intention of the overweight adults to continue the usage of wearable devices for sustained health monitoring is **'privacy concerns'**. Some participants were seriously concerned that their vital signs might fall into the wrong hands which could use the information against them. For this reason, their behavioural intention to use wearable devices for sustained health monitoring might be adversely affected.

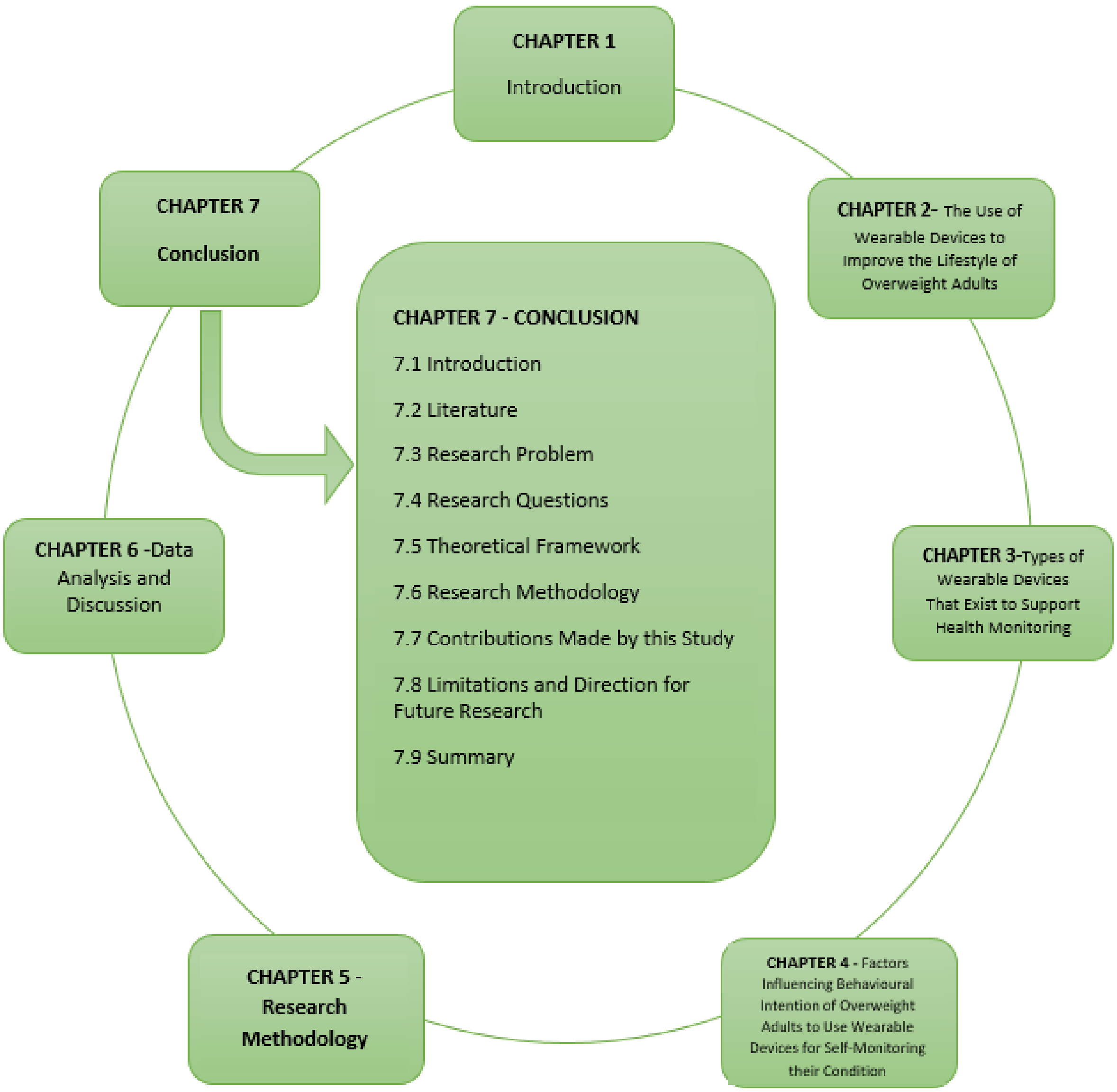
6.8 Chapter Summary

This chapter dealt with the analysis and discussion of qualitative data on the factors influencing the behavioural intention of overweight adults' to use wearable devices for sustained health monitoring. The results of the analysis revealed that the wearable devices were **useful** to their users because they enabled the users to achieve the goal of sustained health monitoring. The conclusion on the perceived usefulness of the wearable devices was reached because the majority of the participants were using wearable devices to record their vital signs in order to monitor their health.

Another conclusion that emerged from the analysis and discussion of data was that the importance of the wearable devices in ensuring sustained health monitoring was **confirmed.**

Based on the narratives of the participants, the majority of the participants confirmed that the use of wearable devices has enabled them to achieve their goal of weight loss. Therefore, since the majority of the participants agreed that their wearable devices were useful and also confirmed the efficacy of wearable devices in ensured sustained health monitoring, it could be inferred that the majority of the participants were **satisfied** with the use of wearable devices for sustained health monitoring. Also, from the analysis and discussion of data, the researcher concluded that the majority of the participants showed a clear **intention of continuous usage** of wearable devices for sustained health monitoring. However, based on the narratives of some of the participants, the major factors that may inhibit the continuous usage of wearable devices for sustained health monitoring are **privacy concerns**, **costs of obtaining wearable devices, theft, frequent charging and short battery life of wearable devices and bulkiness of some wearable devices**. Also, as the analysis and discussion revealed, some users of the wearable devices expressed that while wearable devices could allow the users to monitor their stress levels, dietary and nutritional intake and detection of early symptoms, they were not adequately giving the users perceived behavioural control over sustained health monitoring.

CHAPTER 7


CHAPTER 1
Introduction
CHAPTER 2- The Use of Wearable Devices to Improve the Lifestyle of Overweight Adults
CHAPTER 3-Types of Wearable Devices That Exist to Support Health Monitoring
CHAPTER 4 - Factors Influencing Behavioural Intention of Overweight Adults to Use Wearable Devices for Self-Monitoring their Condition
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Conclusion
CHAPTER 7 - CONCLUSION
7.1 Introduction
7.2 Literature
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7.4 Research Questions
7.5 Theoretical Framework
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7.7 Contributions Made by this Study
7.8 Limitations and Direction for Future Research
7.9 Summary

CONCLUSION

7.1 Introduction

In Chapter Six, results were presented, analysed and discussed. From the results and discussions, factors that positively influenced behavioural intention for continuance usage of wearable devices for sustained health monitoring were highlighted and discussed. Also, inhibitive factors to behavioural intention for continuance usage of wearable devices for sustained health monitoring were noted. It should be noted that both positive and inhibitive factors to behavioural intention were obtained from empirical data, Confirmation-Expectation Model and existing literature. Essentially, this chapter is divided into seven sections. The first deals with the summary of the literature. The second section presents the summary of the research problem. The third section reminds the reader of the research questions. The fourth section presents the summary of the theoretical framework. The fifth section deals with the summary of the research methodology. The sixth section is the contributions made by the study and recommendations; while the last section presents the limitations and direction for future studies.

7.2 Literature

The first part of the literature examined the use of wearable devices in improving the lifestyle of overweight adults. The common risk factors associated with overweight, its complications as well as effective approach for treating overweight prevalence were discussed. The use of technology is considered as innovative solution to improve individual lifestyle and healthcare systems. The literature further highlighted the effectiveness of wearable devices for physical fitness and weight loss as it revealed general improvement in physical activity among overweight adults wearing these devices. Wearable devices helped to attain the major objective of facilitating healthy living lifestyle and changing unhealthy lifestyle behaviour of overweight adults to avert obesity. Also, a health monitoring device is efficient in improving the lifestyle of obese patients as it permits patients to effectively attain eating objectives, it lessens cognitive resource exhaustion, and does not decrease the pleasurable experience derived from eating. Wearable devices facilitate overweight adults' access to medical treatment and a more efficient means of monitoring and managing their health personally, by taking more control of their own health-related behaviours.

The advantages and disadvantages of wearable devices for sustained health monitoring were explained.

The second part of the literature looked at the various types of wearable technologies that exist to support health monitoring. Wearable devices technology is usually presented in the form of a bangle, wristwatch, or pendant and clothes that give feedback of users' everyday activities. Although different types of wearable devices presently exist on the market, they can be categorised into fitness and wellness trackers, implantable, necklace, smart glasses, smart clothes and smart belts. Thereafter, different types of fitness and wellness trackers were discussed. The fitness and wellness trackers included Fitbit, Jawbone, Nike+ FuelBand, Garmin, Polar, Samsung Gear Fit and Apple. The fitness and wellness trackers were capable of assisting overweight adults to attain their fitness goals as well as obtaining precise information about position and movement. Lastly, other wearable devices available to support health monitoring such as necklaces, implantables, smart glasses, smart clothes and smart wearable devices were also explained.

The last part of the review examined the factors that would influence behavioural intention of overweight adult's to use wearable devices for self-monitoring. The Expectation Confirmation Model (ECM) was used adequately to understand users' satisfaction and their post-adoption behaviour by various researchers. The ECM posited that overweight adults' continuance intention of wearable devices usage was focused on three elements. These elements were satisfaction with the wearable devices, the degree of their confirmation, and post-adoption behaviour which is determined by perceived usefulness. The findings from literature revealed that satisfaction was the strongest determinant of overweight adults' continuance intention to use wearable devices, followed by perceived usefulness. Also, confirmation had previously been validated as third factors inflicting behavioural intention of use of wearable devices. Overweight adults' expectation confirmation was positively connected to their perceived usefulness. Perceived usefulness was more closely associated with acceptance intention, whereas satisfaction played a significant part in continuance intention.

7.3 Research Problem

The volume of wearable devices that can be used for sustained health monitoring purposes is continuously growing within the healthcare sector. These devices allow users to track their own activity levels in real time. However, the integration of these devices into users' daily life presents an array of challenges such as privacy concerns, reliability and validity as well as aesthetics properties (Piwek, Ellis, Andrews, & Joinson 2016; Rapp, & Cena, 2015). Maintaining an active lifestyle through the use of wearable devices is vital for overweight adults in order to improve their activity levels, but how to persuade them to utilise the device remains a difficult issue (Chen *et al.*, 2016). Jakicic *et al*. (2016) found that when overweight users started using wearable devices they only used them for a short period of time. There has been an open demand for research into the behavioural intention to use wearable devices but only a few studies have explored this area of research thus far (Bice, Ball, & McClaran, 2015; Wiederhold, 2015).

7.4 Research Questions

The primary research question that was investigated in this study is: **How can the behavioural intention of overweight adults in South Africa to make use of wearable devices be influenced for sustained health monitoring?** The aim of this study was to find out enhancing and inhibitive factors of behavioural intention among the overweight adults to continue using wearable devices for sustained health monitoring. In order to achieve this aim, the following sub-questions were formulated:

1. **How can wearable devices improve the lifestyle of overweight adults' in South Africa?** In Chapter Two, the effectiveness and importance of wearable technologies to improve overweight adults' lifestyle were investigated. This question further identified the benefits and characteristics of wearable devices and persuasive technologies available to overweight adults.
2. **What types of wearable devices exist to support health monitoring?** In Chapter Three, various types of wearable technologies that exist to support health monitoring were discussed. Wearable devices are increasingly gaining popularity. There are various wearable devices available in the market, ranging from smart watches, clothes, glasses, shoes and fitness trackers.
3. **What factors will influence behavioural intention of overweight adults' to use wearable devices for self-monitoring?** In Chapter Four, factors influencing the behavioural intention of overweight adults to use wearable devices for self-monitoring

were reviewed. Wearable devices have the potential to support self-monitoring by compiling, storing, tracking and providing responses about users' activity levels.

A framework for behavioural intention of overweight adults to use wearable devices for sustained health monitoring was developed. This framework visually presents both enhancing and inhibitive factors of behavioural intentions for the overweight adults to continue using wearable devices for sustained health monitoring. The next section provides a summary of the Confirmation-Expectation Model that was used to construct the framework.

7.5 Theoretical Framework

This research adopted the Expectation Confirmation Model (ECM) developed by Bhattacherjee (2001b). The ECM originated from Expectation Confirmation Theory (ECT). The ECT was originally proposed by Oliver (1980) in marketing research mostly to analyse consumer repurchase behaviour and satisfaction. Bhattacherjee (2001b) developed and tested the ECM based on the Technology Acceptance Model (TAM) and Expectation Confirmation Theory (ECT). The ECM was one of the foremost pieces of research examining the distinction between technology acceptance and Information Systems (IS) continuance intention being considered. The ECM is formulated based on four main constructs: confirmation, perceived usefulness and satisfaction leading to IS continuance intention. Confirmation refers to the coherence between the expectation and its actual results while perceived usefulness explains users' judgement of the expected outcome from IS usage (Bhattacherjee, 2001b). Also, satisfaction of IS actual performance posits IS continuance intention.

The ECM has been used in studies such as adoption and continued usage of radio frequency identification (Hossain, & Quaddus 2011); online banking users (Bhattacherjee, 2001a); usage of mobile data service (Chen, Liu, & Lin, 2013). Nematolahi, Kafashi, Sharifian, and Monem (2017) investigated users' continuous intention to use picture archiving and communication systems in a teaching hospital. Findings from the study indicated that perceived usefulness, expectation confirmation and satisfaction were factors influencing intention of medical practitioners to use picture archiving and communication systems.

When applying ECM to this study, overweight adults formed initial expectations about use of wearable devices for sustained health monitoring which, in turn, initiated perceived usefulness of the devices. Afterwards, the users' of the devices were able to assess the coherence between the initial expectation and the actual benefits from wearable devices usage for sustained health monitoring. Thereafter, the outcomes of assessment of the usage would determine continued or discontinued future use of wearable devices by overweight adults. Thus, the use of ECM provided a better knowledge of the factors that influenced overweight adult's intentions to use wearable devices for sustained health monitoring.

7.6 Research Methodology

Research design is the process of turning research objectives and questions into a research project. This study adopted a qualitative research approach. According to Mertens (2010), the qualitative approach is formulated to provide an in-depth detail of specific procedures in terms of the meaning people give to them. The qualitative approach includes inductive logic, discovery, contextual, complexity, exploration and selection of a variety of empirical materials (Mertens, 2010). These are important as they allowed the researcher to understand the factors that influenced behavioural intention of overweight adults' to make use of wearable devices for sustained health monitoring.

The population that was used for this research project were overweight adults who are users of fitness tracking devices in East London, South Africa. The sample size for the study participants was 20 overweight adults and users of fitness tracking devices; participants' ages ranged from 18 - 59 years. Overweight was determined by using the respondents' body mass index (BMI). The WHO (2016) guidelines state that people with a BMI between 25 kg/m^2 and 29.9 kg/m^2 can be considered to be overweight. The BMI was determined by dividing the respondents' individual weights by their heights. All volunteer respondents were asked for permission to measure their weight and height prior to the start of the study. This was explicitly specified in all recruitment materials. The researcher employed a purposive sampling technique to identify the overweight participants.

A thematic analytic method was adopted in this study. Thematic analysis provides a robust and accurate approach to data analysis in qualitative studies. Thematic analysis is mostly used for documenting patterns or themes, examining, pinpointing and identifying meanings within data

(Braun, & Clarke, 2006). Thus, this study adopted a thematic analysis to investigate how overweight adults' behavioural intentions to make use of wearable devices could be influenced for sustained health monitoring. Data provided by participants were grouped and summarised into relevant patterns or themes to answer the main research question.

Interview: For this study, a semi-structured interview was used to obtain deep insights into how overweight adults' behavioural intentions to make use of wearable devices could be influenced for sustained health monitoring. A pre-established set of questions in the semi-structured interview by the researcher further provided information on issues relating to behavioural intention to make use of wearable devices. The interview questions were adapted from the ECM in order to answer the research questions (Oliver, 1980; Bhattacherjee, 2001a). Respondents were recruited for this study through email and print advertisements.

Literature search: In addition to the interview conducted, this study used a literature search to answer and analyse the research question. Both literature and grey literature such as reports, documents, academic journals, books, and conference proceedings were used. In this study, electronic databases such as PubMed, Science Direct, Journal of Medical Internet Research (JMIR), ResearchGate, ACM Digital Library, Google Scholar and others were used to find significant literature.

7.7 Contributions Made by this Study

The study developed a framework showing factors influencing behavioural intention of overweight adults to continue using wearable devices for sustained health monitoring. In this framework, this study indicated both enhancing and inhibitive factors that influenced behavioural intention to continue usage of wearable devices for sustained health monitoring. The confirmation, perceived usefulness and satisfaction of overweight adults were found to be enhancing constructs of behavioural intention to continue usage of wearable devices for sustained health monitoring. The realisation of weight loss, monitoring of daily activities and calories through the use of wearable devices positively influenced the behavioural intention of the users of wearable devices to continue their usage.

However, the framework identified some inhibitive factors that could adversely affect the behavioural intention to continue using wearable devices for sustained health monitoring. These inhibitive factors are discussed below:

- **Short battery life of the wearable devices:** It was found that frequent charging and short battery life of wearable devices is an inhibitive factor to continuance usage of wearable devices. Based on this study, the researcher suggested that the makers of wearable devices should improve on battery quality of wearable devices so that the users can use the devices for a considerably longer time and also to avoid the stress of frequent charging of the devices.

- **Cost:** It was found that prices for upgrading are a factor that could discourage the continuance usage of wearable devices. The analysis revealed that many people in economically disadvantaged neighbourhoods might not be able to afford the high cost of wearable devices or some people could not be able to get wearable devices that are more efficient for sustained health monitoring. From this finding, the researcher suggested that the makers of wearable devices make the prices for procuring wearable devices more affordable, especially for low income people.

- **Fear of robbery:** The analysis revealed that the fear of being robbed could discourage some users from continuance usage of wearable devices for sustained health monitoring. The researcher suggested that the South African government should provide security operatives in isolated areas where people are not feeling secure. The researcher posited that if adequate security operatives are provided in isolated or crime-prone areas, people can buy wearable devices of high values without fear of being robbed or attacked.
- **Bulkiness of some wearable devices:** The analysis of data revealed that the bulkiness of some wearable devices could inhibit the behavioural intention of the users of wearable devices to continue using the devices for sustained health monitoring. Based on this finding, the researcher recommended that the makers of wearable devices should make the devices less bulky so that they can be easily carried around by the users.

- **Privacy concerns about wearable devices:** From the analysis of data, it was found that some participants pointed out that their privacy is at stake as their vital signs could be easily seen and used by third parties. Based on this finding, it was recommended that the makers of wearable devices should assure the users of their privacy and confidentiality by providing the needed interfaces for this purpose.

7.8 Limitations and Direction for Future Research

The study was purely qualitative, and consequently, the sample size was small. This implies that the findings from this study cannot be generalised. However, the researcher was able to understand enhancing and inhibitive factors that influenced behavioural intention of the selected overweight adults to continue using wearable devices for sustained health monitoring. In order to arrive at findings that are generalisable, future researchers should use a considerably larger sample size. Another limitation of this study is that it examined only overweight adults. Therefore, the findings from this study are only applicable to the selected overweight adults in East London, South Africa. The researcher, however, suggested that future studies should extend to adults with normal weights and those who are obese. In addition, future studies should look at the influence of privacy concerns on behavioural intention to the usage of wearable devices for sustained health monitoring among the general population.

7.9 Summary

The study developed a framework showing factors influencing behavioural intention of overweight adults to continue using wearable devices for sustained health monitoring. The confirmation, perceived usefulness and satisfaction of overweight adults were found to be enhancing constructs of behavioural intention to continue usage of wearable devices for sustained health monitoring. The realisation of weight loss, monitoring of daily activities and calories through the use of wearable devices positively influenced the behavioural intention of the users of wearable devices to continue their usage.

However, the major factors that might inhibit the continuous usage of wearable devices for sustained health monitoring were privacy concerns, costs of obtaining wearable devices, theft, frequent charging and short battery life of wearable devices and bulkiness of some wearable devices. Also, as the analysis and discussion revealed, some users of the wearable devices expressed that while wearable devices could allow the users to monitor their stress levels, dietary and nutritional intake and detection of early symptoms, they were not adequately giving the users perceived behavioural control over sustained health monitoring.

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Appendices

Appendix A- Ethical Clearance Certificate

University of Fort Hare
Together in Excellence

ETHICAL CLEARANCE CERTIFICATE
REC-270710-028-RA Level 01

Certificate Reference Number:	ISA051SOGU01
Project title:	**The factors influencing the behavioral intention of overweight adults' to use wearable devices for sustained health monitoring.**
Nature of Project	Masters in Information Systems
Principal Researcher:	Oluwaseyi Caleb Ogundele
Supervisor:	Dr N Isabirye
Co-supervisor:	Dr L Cilliers

On behalf of the University of Fort Hare's Research Ethics Committee (UREC) I hereby give ethical approval in respect of the undertakings contained in the above-mentioned project and research instrument(s). Should any other instruments be used, these require separate authorization. The Researcher may therefore commence with the research as from the date of this certificate, using the reference number indicated above.

Please note that the UREC must be informed immediately of

- Any material change in the conditions or undertakings mentioned in the document
- Any material breaches of ethical undertakings or events that impact upon the ethical conduct of the research

The Principal Researcher must report to the UREC in the prescribed format, where applicable, annually, and at the end of the project, in respect of ethical compliance.

Special conditions: Research that includes children as per the official regulations of the act must take the following into account:

Note: The UREC is aware of the provisions of s71 of the National Health Act 61 of 2003 and that matters pertaining to obtaining the Minister's consent are under discussion and remain unresolved. Nonetheless, as was decided at a meeting between the National Health Research Ethics Committee and stakeholders on 6 June 2013, university ethics committees may continue to grant ethical clearance for research involving children without the Minister's consent, provided that the prescripts of the previous rules have been met. This certificate is granted in terms of this agreement.

The UREC retains the right to

- Withdraw or amend this Ethical Clearance Certificate if
    - Any unethical principal or practices are revealed or suspected
    - Relevant information has been withheld or misrepresented
    - Regulatory changes of whatsoever nature so require
    - The conditions contained in the Certificate have not been adhered to

- Request access to any information or data at any time during the course or after completion of the project.

- In addition to the need to comply with the highest level of ethical conduct principle investigators must report back annually as an evaluation and monitoring mechanism on the progress being made by the research. Such a report must be sent to the Dean of Research's office

The Ethics Committee wished you well in your research.

Yours sincerely

Professor Pumla Dineo Gqola
Dean of Research

05 March 2018

Appendix B- Ethics Research Confidentiality and Informed Consent Form

NAME OF APPLICANT Ethics Human 2016

<< Oluwaseyi C. Ogundele >> OFFICE USE ONLY

Ref	Date

University of Fort Hare
Together in Excellence

Ethics Research Confidentiality and Informed Consent Form

The University of Fort Hare / Information Systems Department is asking 20 users of wearable health monitoring to answer some questions, which we hope will benefit your community and possibly other communities in the future.

The University of Fort Hare / Information Systems Department is conducting research regarding the factors influencing the behavioural intention of overweight adults' to use wearable devices for sustained health monitoring. We are interested in finding out more about the factors influencing the sustained use of wearable devices for health monitoring in South Africa. More specifically, we are carrying out this research to help understand users post acceptance elements of wearable health monitoring devices which will promote continuance intention.

The study will be conducted according to the International Declaration of Helsinki for research on human subjects. The University Research Ethics Committee has approved this research project and the Ethical Clearance number is ISA051SOGU01. The Committee reserves the right to inspect the research records collected during this research project in order to ensure that the project is being conducted ethically.

Please understand that you are not being forced to take part in this study and the choice whether to participate or not is yours alone. However, we would really appreciate it if you do share your thoughts with us. If you choose not take part in answering these questions, you will not be affected in any way. If you agree to participate, you may stop me at any time and tell me that you don't want to go on with the interview. If you do this there will also be no penalties and you will NOT be prejudiced in ANY way. Confidentiality will be observed professionally.

I will not be recording your name anywhere on the questionnaire and no one will be able to link you to the answers you give. Only the researchers will have access to the unlinked information. The information will remain confidential and there will be no "come-backs" from the answers you give.

The interview will last around 60 minutes *(this is to be tested through a pilot)*. I will be asking you questions and ask that you are as open and honest as possible in answering these questions. Some questions may be of a personal and/or sensitive nature. I will be asking some questions that you may not have thought about before, and which also involve thinking about the past or the future. We know that you cannot be absolutely certain about the answers to these questions but we ask that you try to think about these questions. When it comes to answering questions there are no right and wrong answers. When we ask questions about the future we are not interested in what you think the best thing would be to do, but what you think would actually happen.

Document approved by UREC: 27 July 2015, V01

NAME OF APPLICANT Ethics Human 2016

<< Oluwaseyi C. Ogundele >>

OFFICE USE ONLY

Ref	Date

If possible, our organization would like to come back to this organization once we have completed our study to inform you and the organization of what the results are and discuss our findings and proposals around the research and what this means for the employees of the organization.

You can contact me or my supervisors if you have any further questions:

Mr. Oluwaseyi Ogundele
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INFORMED CONSENT

I hereby agree to participate in research regarding *The Factors Influencing the Behavioural Intention of Overweight Adults' to use Wearable Devices for Sustained Health Monitoring.* I understand that I am participating freely and without being forced in any way to do so. I also understand that I can stop this interview at any point should I not want to continue and that this decision will not in any way affect me negatively.

I understand that this is a research project whose purpose is not necessarily to benefit me personally.

I have received the telephone number of a person to contact should I need to speak about any issues which may arise in this interview.
I understand that this consent form will not be linked to the questionnaire, and that my answers will remain confidential.

I understand that if at all possible, feedback will be given to my community on the results of the completed research.

……………………………….
Signature of participant **Date**……………………

I hereby agree to the tape recording of my participation in the study

……………………………….
Signature of participant **Date**…………………….

Document approved by UREC: 27 July 2015, V01

Appendix C- Interview Guide

The Factors Influencing the Behavioural Intention of Overweight Adults' to use Wearable Devices for Sustained Health Monitoring

Section 1: Demographics Information

This section aims at obtaining the basic information of the respondent.

1. What is your gender?

Female		Male	

2. What is your age group?

18 – 25 years	26 – 35 years	36 – 50 years	51 – 59 years

3. What is your BMI?

4. What type of wearable device are you using?

…………………………………………………………………………………………

5. What motivated you to buy the device?

…………………………………………………………………………………………
…………………………………………………………………………………………

6. How long have you been using the device?

…………………………………………………………………………………………
…………………………………………………………………………………………

7. How did you find out about the device?

…………………………………………………………………………………………
…………………………………………………………………………………………

8. What functions does the wearable device have?

Elaborate……………………………………………………………………………………
…………………………………………………………………………………………

9. Which of the functions are you using it for?
…………………………………………………………………………………………
…………………………………………………………………………………………

10. When monitoring your health, which daily physical activities do you normally consider or look at?
…………………………………………………………………………………………
…………………………………………………………………………………………

Section 2: **Substantive Questions**

IS Continuance

11. How often do you wear the device?
…………………………………………………………………………………………
…………………………………………………………………………………………

12. How often do you use the device for health monitoring?

…………………………………………………………………………………………
…………………………………………………………………………………………

13. Has the use of the device increased or decreased since you purchased the device?
…………………………………………………………………………………………
…………………………………………………………………………………………

14. Has your daily activities and weight loss increased or decreased since you purchased it?
…………………………………………………………………………………………
…………………………………………………………………………………………

15. Have you become more conscious of your daily nutrition and dietary intake?
…………………………………………………………………………………………
…………………………………………………………………………………………

16. Have you become more conscious of the management of your stress levels?
…………………………………………………………………………………………
…………………………………………………………………………………………

17. Do you intend to continue using a wearable device for health monitoring?

    Why……………………………………………………………………………………………
    ……………………………………………………………………………………………………

18. Do you intend to continue using a wearable device rather than using any manual means of health monitoring?

    Elaborate………………………………………………………………………………………
    …………………………………………………………………………………………………...

Satisfaction

19. Does your device support your health monitoring objectives? If yes/no, how/why?

    Elaborate………………………………………………………………………………………
    …………………………………………………………………………………………………....

20. Was the wearable device designed to be easy to use? in terms of user-friendliness / intuitiveness
    Explain…………………………………………………………………………………………
    ……………………………………………………………………………………………………

Perceived Usefulness

21. Do you think wearable devices enable you to have greater control of your health monitoring?

    Explain…………………………………………………………………………………………
    ……………………………………………………………………………………………………

22. Do you think the wearable device you are using enables you to improve and monitor your daily activities and weight loss?
    Explain…………………………………………………………………………………………
    ……………………………………………………………………………………………………

23. Do you think the wearable device you are using allows you to improve and monitor your daily nutrition and dietary intake?

    Explain………………………………………………………………………………………
    ………………………………………………………………………………………………

24. Do you think the wearable device you are using enables you to detect early symptom of illnesses?

    Explain………………………………………………………………………………………
    ………………………………………………………………………………………………

25. Do you think the wearable device you are using is capable of improving medication adherence?

    Explain………………………………………………………………………………………
    ………………………………………………………………………………………………

26. Do you think the wearable device you are using enables you to monitor your stress levels?

    Explain………………………………………………………………………………………
    ………………………………………………………………………………………………

Confirmation

27. Has your experience of the wearable device met your expectations? Yes/No

    Why……………………………………………………………………………………………
    ………………………………………………………………………………………………

28. Do you have any privacy or security concern after using the wearable device?

    Elaborate……………………………………………………………………………………
    ………………………………………………………………………………………………

29. Do you think privacy and security concerns will hinder continuous use of this device? Explain……………………………………………………………………………………..
    ……………………………………………………………………………………………..

30. Based on your concern, will you recommend the use of a wearable device to someone else?

    ………………………………………………………………………………………………
    ………………………………………………………………………………………………

31. Are there any expectations that were not met by the use of a wearable device?
Explain………………………………………………………………………………………
……………………………………………………………………………………………….

Thank you for your time.

Appendix D- Proofreading Certificate

TO WHOM IT MAY CONCERN

I have 42 years' experience in the teaching profession, both at high school and tertiary level. In my last position before retiring in December 2016, I was a Teaching and Learning Consultant and had acted as Manager of the Teaching and Learning Centre (TLC) of the University of Fort Hare on three different occasions. As a consultant, I facilitated modules on the Post Graduate Diploma in Higher Education and Training (PGDHET) and also evaluated lecturers' teaching and their courses. My skills set allowed me to focus on management, language, research and student development. Activities which speak to this included being the Co-ordinator of the Language and Writing Advancement Programme (LWAP) and the Supplemental Instruction Programme (SI) for two years plus being the Editor of the TLC's bi-annual newsletter for approximately eight years.

I hereby certify that I have proofread and edited a Master's thesis submitted to me by **Oluwaseyi Caleb Ogundele** (Student number 201608332) of the University of Fort Hare. His research topic is:

`The Factors Influencing the Behavioural Intention of Overweight Adults to use Wearable Devices for Sustained Health Monitoring'.

I have corrected superficial errors, checked that the Post Graduate assessment requirements have been met as outlined in the UFH General Prospectus and also double-checked the APA referencing style preferred by this department of the university. I trust that the language used accurately reflects the intended meaning of the model proposed for implementation and that the narrative is aligned with the aforementioned. Every effort has been made to avoid confusion or misunderstanding. The principles of confidentiality, accountability and reliability were respected by all parties.

Should there be any questions that arise from this exercise, kindly contact me on lscheckle@gmail.com.

LAScheckle

Linda Scheckle (Private Editing Service) 11 November 2018

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Appendix E- Article presented at The African Conference on Information Systems and Technology, Cape Town, 2018

Ogundele O, Isabirye N. & Cilliers L. (2018). A model to Provide Health Services to Hypertensive Patients through the Use of Mobile Health Technology. 4th African Conference on Information System & Technology, University of Cape Town, South Africa, 9–10 of July 2018.

The article was from BCom Information Systems (Honours) degree that informed the MCom (Information Systems).

Appendix F- Sample of Transcribed Interviews

S/N	Question	Response
1	What motivated you to by the device?	The majority of the participants stated that they were motivated by the fact that the wearable devices enable to them to monitor their weight.
2	What functions does the wearable device have?	Most of the participants stated that they used the device to measure their daily physical activities, monitor their sleep patterns, heart rate as well as their calories intake.
3	Has the use of device increase or decrease since you purchased the device?	Most of the participants said their usage of wearable devices has increased since it serves the purpose for which they are purchased. They stated that since it helps them to monitor their health, they would continue its usage, and even recommend it to their family members, colleagues and friends.
4	Have your daily activities and weight loss increase or decrease since you purchased it?	The majority of the participants noted that their daily physical activities have increased as well as their weight loss. They noted that since they started using the wearable devices for sustained health monitoring, their physical activities have been enhanced because the devices enable them to monitor the level or extent of their physical activities. The wearable devices give them clue regarding the level of physical activities that they should do in order to achieve the goal of weight reduction.
5	Have you become more conscious about your daily nutrition and dietary intake?	The majority of the participants stressed that they have been more conscious about their daily nutrition and dietary intake through the help of wearable devices. They stressed that wearable devices they are using have enable them to monitor their dietary intake and daily nutrition. Since the goal is to mitigate overweight, they used wearable devices to control the amount of their dietary intake and daily nutrition. However, some participants were not too conscious of their daily nutrition and dietary intake through the usage of wearable devices. But, this might due to their behaviour; not the fault of the devices. Also, the narratives of some participants suggested that even if the device has the function, they are not motivated to use that function to monitor their dietary intake and nutrition.
6	Have you become more conscious about the management of your stress?	About half of the participants said that wearable devices are useful in monitoring and managing their stress levels. They noted that the wearable devices will give them notifications about their health which they can use to determine whether they have been stressed out or not. However, some participants said that wearable devices were inefficient in managing their stress levels. Also, some participants opined that their wearable devices did not have functions where they could manage their stress levels. It should be noted that some

		wearable devices do not have these functions. Also, some users of wearable devices are not aware of the functions and how those functions can help indirectly in monitoring their stress levels. Moreover, it is possible that some people might not be able to afford wearable devices that have functions that can indirectly monitor stress levels.
7	Do you think the wearable device you are using enables you to detect early symptoms?	Eleven participants argued that their wearable devices had helped them in detecting early symptoms of disorders. Their position is that wearable devices could be used to detect early symptoms of disorders through the monitoring of heart rate and stress levels. From heart rate and stress levels, one can detect some symptoms of disorders. However, nine out of the 20 participants disagreed that the use of wearable devices can allow their users to detect early signs of disorders. .
8	Do you think the wearable device you are using is capable of improving medication adherence?	Seven out of the 20 participants were of the view that some of them (wearable devices) did. Some of these participants stressed that if 'I have the right one. It can help because I know there are devices that can actually remind you that it is time to take this, it is time to do this. I think it will be of great help. It will just be like us setting an alarm for us to do some certain thing. It will actually be of great help'. However, thirteen participants expressed that wearable devices they were using could not be used for ensuring adherence to medication. Their main argument is that their devices do not have that function that will enable to adhere to medication.
9	Do you have any privacy or security concern after using the wearable devices?	The narratives on the concerns for privacy in the use of the wearable devices among the overweight adults are nuanced. Some participants were of the view that their information could not be used by the third parties because it was only about their physical activities. But, some participants disagreed on this. Their main reason for disagreement was based on their information about the number of calories burnt being personal to them. On the other hand, some participants expressed that they had serious security and privacy concerns in the usage of wearable devices for sustained health monitoring.