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Incentives and physical activity

An assessment of the association between Vitality's Active Rewards with Apple Watch benefit and sustained physical activity improvements

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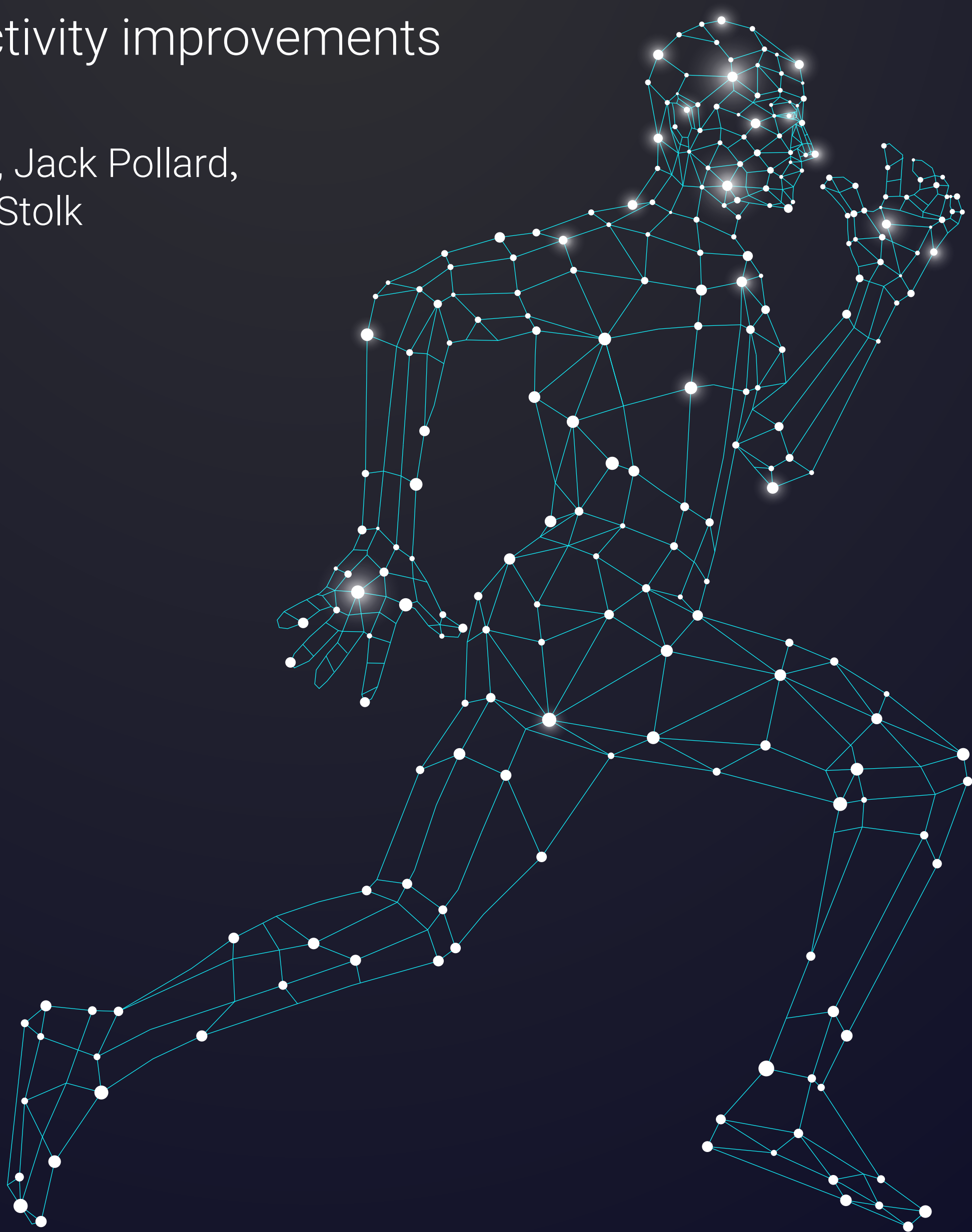

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Preface

Through its Vitality subsidiary, Discovery – a multi-national insurance group based in South Africa – commissioned RAND Europe to conduct an independent evaluation of the Vitality Active Rewards with Apple Watch benefit. The objective of this study is to assess whether the benefit enhances physical activity among members of the Vitality programme, in comparison to members who participate in another physical-activity incentive called Vitality Active Rewards. The study covers three different countries: the United Kingdom, the United States and South Africa.

The report's findings directly contribute to the scientific literature in the area of behavioural science that examines the associations between different types of incentives and physical activity.

Executive summary

Background

The benefits of physical activity include a lower risk of some of the major non-communicable diseases, including hypertension, cardiovascular disease, diabetes and cancer. In addition physical activity can have positive effects on maintaining healthy body weight and mental health, with insufficient physical activity associated with a substantial global economic burden (Ding et al. 2016). However, roughly one third of the global adult population is not meeting the minimum weekly level of physical activity recommended by the World Health Organisation (Hallal et al. 2012; Guthold et al. 2018). In recognition of the link between physical activity and reduction of non-communicable diseases, the World Health Organisation (WHO) has established the Global Action Plan on Physical Activity 2018–2030, which aims to promote physical activity, provide updated guidance for countries and establish a framework of effective and feasible policy actions to increase physical activity at all levels (WHO, 2018). With the goal of tackling inactivity, Discovery, a multi-national insurance group based in South Africa, launched two types of incentives to make people more active: (1) Vitality Active Rewards; and (2) Vitality Active Rewards with Apple Watch.

Firstly, Vitality Active Rewards is a weekly gain-framed incentive where individuals are rewarded for tracking and reaching different thresholds of physical activity. Within Vitality Active Rewards, members consent to track their physical activity through a variety of different devices (e.g. fitness tracker, smart phone) and receive so-called Vitality Points and rewards for reaching different activity thresholds, including light, standard or advanced workouts or events. Different workout or activity events (e.g. light, standard and advanced activity) have similar point weightings so variability due to measurement through different devices is not an issue.

Secondly, alongside Vitality Active Rewards, the Vitality Active Rewards with Apple Watch benefit was introduced to Vitality customers around the world in 2016. Born out of collaboration between Vitality and the technology company Apple, the benefit aims to leverage evidence-based insights from behavioural and actuarial science with Apple's technology to create behaviour change. In essence, the Vitality Active Rewards with Apple Watch benefit is a loss-framed incentive where eligible Vitality members can purchase an Apple Watch at a heavily discounted upfront price, but with monthly repayment amounts linked to different levels of physical activity thresholds the individuals reach per month. Those who undertake requisite levels of activity pay low or zero monthly repayments.

Study objectives

The existing evidence on the associations between incentives and physical activity (e.g. Chokshi et al. 2018) suggests that on average loss-framed incentives can increase activity beyond the levels of gain-framed incentives only. The objective of this study is to assess whether the loss-framed Vitality Active Rewards with Apple Watch incentive is associated with enhanced physical activity levels for Vitality members that take up the benefit, compared to those individuals that only participate in the gain-framed Vitality Active Rewards incentive. The study also examines whether these associations persist over time.

Note that independent of participating in the Vitality Active Rewards incentive and Vitality Active Rewards with Apple Watch benefit, Vitality programme members can earn an assortment of longer term rewards – ranging from discounts on healthy food purchases to discounted flights, amongst others – by engaging in validated healthy lifestyle activities, such as health check-ups, healthy food purchases and tracking their activity through various wearable devices. While this study focuses on whether participating in the Vitality Active Rewards with Apple Watch benefit is associated with physical activity enhancement compared to participating in Vitality Active Rewards only, it is possible to examine whether participating in the Vitality Active Rewards incentive is also leading to higher activity rates compared to participating in the Vitality programme only. This is done to some extent with the results reported in Appendix B, but there are some limitations in this analysis regarding the data availability and accurate measurement of activity levels.

The study contributes to the existing literature in this area of research by using statistical regression methods combined with large-scale population data from Vitality programme members, including a data sample of 422,643 individuals over a time period of 2015 to 2018. Previous studies that examined the associations between (financial) incentives and physical activity are based on relatively small samples of specific populations (e.g. ischemic heart-disease patients). For this reason it may be difficult to extent these findings to other populations or contexts.

Research approach

Using data from Vitality members across three countries – the United Kingdom, the United States and South Africa – we use fixed-effects Poisson regression models to examine whether the uptake of the Active Rewards with Apple Watch benefit leads to an increase in tracked physical-activity across different types of activity levels, compared to participating in Active Rewards only. The statistical approach taken in the analysis adjusts for observed and unobserved individual heterogeneity that is constant over time by examining the same individual, before and after the uptake of the intervention (Vitality Active Rewards with Apple Watch benefit). We conduct a series of robustness checks and also perform a sub-group analysis for an inactive and obese sub-population.

Overall, included in the analytic sample for the United Kingdom are 238,422 individuals, of which 59,237 have taken up the Vitality Active Rewards with Apple Watch benefit. In the sample for the United States, 17,648 individuals are included, of which 8,302 have taken up the Vitality Active Rewards with Apple Watch benefit. For the South African sample, 166,573 individuals are included, of which 23,461 have taken out the benefit. While this analysis is based on a large observational dataset across Vitality programme members of three different countries, and hence increases significantly the sample size and potentially allows the generalisability of the findings to a larger population than previous studies, it has to be highlighted that the Vitality population is not necessarily representative of the full population of a country itself.

Results

Our findings suggest that the uptake of the loss-framed Vitality Active Rewards with Apple Watch benefit is associated with an average 34 percent increase of tracked activity days per month, leading to an additional 4.8 activity days per month in which exercise has been tracked. This is compared to the population of Vitality members that only participate in the gain-framed Vitality Active Rewards incentive. As Table S.1 reports, there is some variation across the three country samples, with the largest percentage increase in total activity days in South Africa (44.2 percent), followed by the United States (30.6 percent) and the United Kingdom (27.7 percent). The variation of the associations across countries may be due to a combination of the selectiveness of the populations taking up the Vitality Active Rewards with Apple Watch benefit, but also due to country-specific differences in the incentive structures.

Looking at the different exercise intensity categories – light, standard and advanced activity – the largest relative increase is among the advanced activity days, suggesting that there is not only an overall increase in activity levels but also an increase in more intense exercise events. The largest absolute increase in advanced activity days is reported in the UK sample, where the uptake of the Vitality Active Rewards with Apple Watch benefit is associated with an average increase of 1.6 days of tracked advanced activity per month, followed by South Africa (1.3 days) and the United States (1.2 days)

Table S.1: Changes in activity levels after uptake of the Vitality Active Rewards with Apple Watch benefit

	United Kingdom		United States		South Africa	
	percent	days	percent	days	percent	days
Total activity days	27.7%	3.6	30.6%	4.7	44.2%	6.1
Light activity days	18.3%	0.8	19.3%	1.4	48.8%	2.1
Standard activity days	25.1%	1.1	36.5%	2.0	30.1%	2.3
Advanced activity days	37.4%	1.6	52.4%	1.2	71.1%	1.3

Notes: additional days calculated by applying percentage change of activity to average days of activity per month for the Vitality Active Rewards with Apple Watch intervention group pre-intervention, as reported in Table 3.1.

Furthermore, a sub-group analysis suggests that the Vitality Active Rewards with Apple Watch benefit may also incentivise sub-populations that initially tend to be more inactive, such as obese individuals, to become more active. In this at-risk sub-population the uptake of the benefit is associated with an average increase in tracked activity levels in the range of 109 percent (SA), 160 percent (UK) and 200 percent (US), which are in relative terms larger than for the whole country-specific samples. These percentage changes correspond to an absolute increase in activity days per month of about 4.5 days (South Africa), 5.7 days (United Kingdom) and 1.8 days (United States). However, it is important to highlight that the uptake rate of the benefit is generally lower among this sub-group compared to the overall sample populations.

In addition, we find that the positive associations between the Vitality Active Rewards with Apple Watch benefit and physical activity persist over time (at least over the intervention period of 24 months, the repayment period of the Apple Watch). Moreover, in addition to an overall increase in tracked activity levels, the benefit also tends to be associated with higher levels of intensive activity over time, measured in the total number of advanced activity days per month.

Conclusion

The findings of this study suggest that incentivising physical activity can lead to increased activity levels. Specifically, this study confirms that a loss-framed incentive such as the Vitality Active Rewards with Apple Watch benefit can improve physical activity levels beyond the incentive induced by a gain-framed incentive that only provides individuals with rewards for physical activity, such as the Vitality Active Rewards incentive. This positive association persists when the person is incentivised to maintain this behaviour-change over time. Though more unhealthy individuals are much less likely to take up an incentive of this nature, when they do, the results can lead – on average – to a more pronounced behaviour-change than we see in individuals who are already relatively more active and healthy. This is important when designing health-promotion programmes.

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Abbreviations

AW	Apple Watch
BMI	Body Mass Index
DiD	Differences-in-Differences
VARAW	Vitality Active Rewards with Apple Watch
VAR	Vitality Active Rewards
RCT	Randomised Controlled Trial
RQ	Research Question
PMI	Private Medical Insurance
UK	United Kingdom
US	United States
SA	South Africa
WHO	World Health Organisation

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The views presented in this report are the authors' and remaining errors are also our own.

1 Background

The benefits of physical activity include a lower risk of some of the major non-communicable diseases, including hypertension, cardiovascular disease, diabetes and cancer. In addition, physical activity can have positive effects on maintaining healthy body weight and mental health, with insufficient physical activity associated with a substantial global economic burden (Ding et al. 2016). However, roughly about one third of adults worldwide are not meeting the minimum weekly level of physical activity recommended by the World Health Organisation (Hallal et al. 2012; Guthold et al. 2018). In recognition of the link between physical activity and non-communicable diseases, the World Health Organisation (WHO) has established the Global Action Plan on Physical Activity 2018–2030, which aims to promote physical activity, provide updated guidance for countries and establish a framework of effective and feasible policy actions to increase physical activity at all levels (WHO, 2018).

Providing incentives, including financial incentives, are one way in which private employers and public health programmes have sought to tackle this issue (Sutherland et al. 2008). There is a constituent of scientific literature that seeks to understand what impact different types of (financial) incentives have on the healthy behaviour of individuals, particularly with respect to physical activity.

1.1. The effects of incentives on tackling physical inactivity: evidence from the literature

Existing scientific evidence suggests that financial incentives can have a positive impact on personal health behaviour, particularly physical activity. For instance, Mitchell et al. (2013) conduct a systematic review of 11 studies of Randomised Controlled Trials (RCTs) with the aim of examining the impact of financial incentives on exercise-related behaviours. The review concludes that financial incentives have a positive impact on exercise, even among a sedentary adult population. Furthermore, interventions involving unconditional incentives (i.e. those not related to performance, such as upfront free gym memberships), appeared to be less effective at influencing exercise-related behaviour. The review also finds that adherence to exercise drops after the incentive is removed, with only one study observing that exercise levels were sustained for over a year. In a more recent systematic review of RCTs examining the impact of financial incentives on physical activity, Barte & Wendel-Vos (2017) identify 12 relevant studies. Of these, four studies examined unconditional incentives and eight considered conditional incentives (i.e. a reward for performance, such as cash for doing a certain number of steps or attending a fitness class). Physical activity was the primary outcome of interest, but other outcomes, such as sedentary behaviour, fitness and weight, were also considered. The authors conclude that unconditional incentives have no impact on physical activity, or any other outcome of interest. Positive effects are observed among interventions offering a conditional incentive, with those offering incentives for physical activity behaviour rather than attendance achieving the greatest results. However, the presented evidence only suggests an effect in the short-term with the long-term effects of such interventions remaining unclear.

Despite the body of evidence that financial incentives can have a positive impact on physical activity, the vast majority of studies are based on highly context-specific populations. For example, Tanham et al. (2014) conduct a three-arm RCT, with 66 participants, comparing the impact of a financial incentive (e.g. a discount for fitness classes and a fitness programme), and a so-called 'Implementation Intention Prompt' (e.g. a regular nudge about the importance of physical activity and a programme) to a control group only receiving the fitness programme. A similar significant increase in physical activity and subsequent weight loss is observed in both intervention groups compared to control group. These conclusions suggest that, in certain contexts, financial incentives may not be necessary to achieve the desired changes in physical activity levels.

There are further ways that financial incentives can be presented to influence the impact they have, especially when they aim to leverage insights from behavioural economics. For instance, financial incentives can be allocated based on the performance of an individual, a group of people, or a combination of both. Patel et al. (2016a) conduct an RCT among 304 individuals employed by a single US employer to determine the impact of such incentives on physical activity levels by measuring steps per day. Participants are either allocated to a control group receiving daily performance feedback but no financial incentive, or one of three intervention groups receiving financial incentives with daily feedback: 1) based on individual performance, 2) based on team performance, or 3) based on a combination of individual and team performance. The findings suggest that only participants in the combined incentive arm achieved a significantly greater number of mean daily steps than the control group, and they are the only group to have a significantly higher proportion of individuals achieving the daily target of 7,000 steps compared to participants in the control group.

Furthermore, the evidence suggests that how the financial incentive is framed matters. For instance, Chokshi et al. (2018) conduct an RCT of wearable activity trackers among ischemic heart-disease patients, with the intervention group receiving loss-framed financial rewards, but not the control group. In a loss-framed incentive intervention, money is allocated upfront to the participant, which could be lost if the activity goals are not achieved. This is in contrast to gain-framed incentives, where participants in an intervention are rewarded by achieving activity goals. In the Chokshi et al. (2018) study, participants receive $14 weekly, but for each day they fail to meet their personalised step count they lose $2 from their $14 weekly budget. The study of 105 individuals ran for 24 weeks, with incentives being withdrawn after 16 weeks, providing an 8-week follow-up period. The findings suggest that the average daily steps increased significantly in the intervention group, with those receiving the financial incentive taking on average around 1,000 more steps per day than those in the control group, with the difference still observed during the 8-week follow-up period.

In a similar study of overweight and obese adults, Patel et al. (2016b) examine the impact of a 13-week financial incentive programme on participants' levels of physical activity, measured in terms of steps per day. Individuals are assigned to either a control group receiving daily performance feedback but no financial incentives, or one of three intervention groups receiving financial incentives with daily feedback: 1) a gain-framed incentive, 2) a lottery incentive, or 3) a loss-framed incentive. Incentives are allocated depending on whether the individual participants meet their target of 7,000 steps per day. Interestingly, only the loss-framed incentive group reports a significantly greater proportion of participant-days accomplishing the target compared to the control group. The participants in the other two intervention groups reported no statistically different physical activity compared to the control group. The study's findings support those of Chokshi et al. (2018), however it is important to mention that the study was carried out among 281 individuals employed by a single organisation in the United States. This may limit the generalisability of the findings for a larger population. Furthermore, among the intervention groups, the daily steps decreased once the incentive was withdrawn with no statistically significant difference compared to the control group.

In summary, the existing evidence suggests that incentive programmes can have a positive impact on personal health behaviour, and in particular on physical activity, but the type of incentive matters. For instance, there is some evidence that gain-framed incentives – where individuals receive rewards for achieving activity goals – can increase activity but the empirical evidence examining the effectiveness is ambiguous. In contrast, financial incentives that are loss-framed, where individuals are paid upfront but lose part of the money if they do not achieve their goals, seem to be more effective in increasing physical activity levels. However, much of the existing evidence is based on relatively small-scale RCT studies with relatively small numbers of participants in very specific contexts (e.g. a specific sub-group of ischemic heart-disease patients) and hence lacks a wider generalisability of the findings to larger populations.[1]

1.2. Vitality's Active Rewards and Active Rewards with Apple Watch Benefit

The Vitality programme, founded in 1997 by Discovery, is a behavioural platform that underpins insurance products around the world. According to Vitality, the programme is built on shared value, wherein incentives are used to encourage healthy behaviour change for its clients. One third of the global adult population is physically inactive (Guthold et al. 2018), so in order to tackle inactivity, Vitality programme members can have access to two incentives that were specifically designed to improve physical activity levels: (1) Vitality Active Rewards; and (2) Vitality Active Rewards with Apple Watch.

Vitality Active Rewards is a weekly gain-framed incentive where individuals are rewarded for tracking and reaching different thresholds of physical activity. Within Vitality Active Rewards, members consent to track their physical activity through a variety of different devices (e.g. fitness tracker, smart phone) and receive so-called Vitality Points and rewards for reaching different activity thresholds, including light, standard or advanced workouts or events. The Vitality Points

1 A more detailed list and summary of the existing literature in this area of research can be found in Appendix A.

structure adjusts for variability due to measurement through different types of devices, with comparable workouts or activity events (e.g. light, standard and advanced activity) having a similar point weighting.

Alongside Vitality Active Rewards, the Vitality Active Rewards with Apple Watch benefit was globally introduced to Vitality customers in 2016. Born out of collaboration between Vitality and Apple, the benefit aims to leverage evidence-based insights from behavioural and actuarial science with Apple's technology to create individual behaviour change. **The Vitality Active Rewards with Apple Watch benefit is a loss-framed incentive** where eligible Vitality members can purchase an Apple Watch at a heavily discounted upfront price, but with monthly repayment amounts linked to different levels of physical activity thresholds the individuals reach per month.

In essence, Vitality Active Rewards provides the underlying incentive platform for the Vitality Active Rewards with Apple Watch benefit, and the two incentives were designed to reinforce each other. The discount on the retail price of the Apple Watch provides the incentive for members to purchase the device and activate the Active Rewards with Apple Watch benefit in the first place, thus reducing a barrier to access associated with technology, and the subsequent loss-framed incentive aims to incentivise individuals to be more active through the activity-linked repayments. For instance, if an individual reaches a specific level of physical activity each month over the 24-month incentive period, they will earn on average a 90 percent total discount on the retail price of the Apple Watch.[2] Specifically, the Vitality Active Rewards with Apple Watch benefit combines three elements:

1. **Behavioural incentive design:** based on behavioural science and insights from research on the effects of loss aversion (e.g. Patel et al. 2016b);
2. **Vitality Active Rewards (VAR):** a dynamic and weekly incentive that encourages members to reach exercise targets, and rewards individuals for the successful attainment of activity goals;
3. **Apple Watch (AW):** a smart watch with powerful health and productivity functionality and broad consumer appeal.[3] Vitality Active Rewards with Apple Watch (VARAW) allows its members to get the latest Apple Watch every two years, leveraging the general appeal of the device to create sustained participation in the programme over time.

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2 Chapter 2 provides a more detailed overview about the Vitality programme and its incentives to enhance physical activity levels.

3 D. Phelan (2018), Forbes, 'Apple Watch Sales Soar To 8 Million In Last Quarter, Apple Owned 2017 Wearables Market', as of October 31 2018: https://www.forbes.com/sites/davidphelan/2018/03/01/apple-watch-sales-soar-to-8-million-in-last-quarter-company-owned-2017-fitbit-huawei-garmin/#418ce5f27e91; N. Statt (2018), The Verge, 'Apple Watch remains best-selling wearable with 4.7 million shipments last quarter', as of October 31 2018: https://www.theverge.com/2018/9/4/17820290/apple-watch-sales-idc-report-best-selling-smartwatch-wearable-market

1.3. Objectives of this study

Against this background, Vitality commissioned RAND Europe to conduct an independent assessment of the Vitality Active Rewards with Apple Watch benefit's effect on physical activity improvements. In essence, this study aims to answer the following two research questions (RQ):

RQ 1: Does Vitality's Active Rewards with Apple Watch lead to physical activity improvements?

The main objective of this study is to examine whether Vitality's Active Rewards with Apple Watch benefit can generate physical activity improvements beyond the potential exercise improvements through the Vitality Active Rewards incentive alone. This analysis is directly contributing to the literature that investigates the associations between loss-framed incentives (i.e. VARAW) and enhanced physical activity. Following the existing literature we would expect the Vitality Active Rewards with Apple Watch benefit to create an additional incentive for performing physical activity compared to a gain-framed incentive such as Vitality Active Rewards. One of the key contributions of this study to the existing literature in this area of research is that it is a large population study. Whereas previous studies focus on very specific sub-groups of the population (e.g. ischemic heart-disease patients), we exploit larger scale data from Vitality's member population across three different countries – the United Kingdom (UK), the United States (US) and South Africa (SA). While this analysis is based on large observational data across Vitality programme members of three different countries, it has to be highlighted that the Vitality population may not necessarily be representative of the full population of a country itself.

In the statistical analysis of this study, across three countries analysed (UK, US, SA), **we compare the recorded activity-days per month of eligible Vitality members enrolled into Vitality Active Rewards (reference group) with the recorded activity-days per month for eligible members enrolled into the Vitality Active Rewards with Apple Watch benefit (intervention group).** This allows us to test the hypothesis implied by the first research question of whether a loss-framed incentive can induce exercising beyond the levels incentivised by a gain-framed incentive.

Furthermore, we examine whether the Vitality Active Rewards with Apple Watch benefit has an activity-enhancing effect for individuals with certain health-related risk factors, such as sedentary lifestyle or a high body-mass index (BMI). This is important as ideally, from a health-system perspective, the intervention would not only incentivise already active populations, but also trigger behavioural change in at-risk populations related to specific health and lifestyle factors.

RQ2: Does Vitality's Active Rewards with Apple Watch benefit lead to sustained levels of physical activity?

Existing RCT studies tend to have limited intervention time-scales, for instance with the intervention active for a few months only and with some weeks of follow-up periods. By contrast, this study aims to analyse data from a two-year intervention phase using observational data from Vitality member records. This enables us to investigate whether the potential associations of the intervention with physical activity are sustained over a longer period of time.

1.4. The structure of this report

The report is structured as follows. Chapter 2 describes the Vitality programme in more detail and its two corresponding incentives that aim to improve physical activity levels: Vitality Active Rewards and Vitality Active Rewards with Apple Watch. Chapter 3 describes the data and methodology applied in the analysis for this report. Chapter 4 describes the results of the empirical analysis, and Chapter 5 outlines the conclusions of the report.

2 The Vitality programme and Vitality's Active Rewards incentive and Active Rewards with Apple Watch benefit

This Chapter provides a more detailed background about the Vitality programme and its related incentives schemes to enhance physical-activity levels, including Vitality Active Rewards and Vitality Active Rewards with Apple Watch.

2.1. The Vitality programme

The Discovery Vitality programme, founded in 1997, is a global behavioural-change platform that underpins insurance products around the world with active businesses in South Africa, the United States, the United Kingdom, China, Canada, Italy and Germany, among others. According to Vitality, the programme is built on shared value, wherein incentives are used to encourage healthy behaviour. Furthermore, the programme aims to continuously leverage the latest insights from medical, behavioural and actuarial science to design evidence-based interventions that lead to healthier lifestyles and health outcomes. In essence, the programme aims to help its members to better understand and manage their own health by providing them with a variety of health interventions, including online health reviews, discounts on gym membership, sports apparel and wearable technology to name but a few. Among other types of interventions, the programme offers eligible members healthy food rebate benefits that have been demonstrably effective in leading to consumption of healthier food alternatives (Sturm et al. 2013).

Generally, it is important to note that the main customer audiences for the Vitality programme differ somewhat across countries. For the UK and South Africa, its main target audience is the insurance market, whereas for the United States, during the study period the target audience has primarily been corporate wellness. This implies that in absolute terms the population of Vitality members tends to be larger on average for the UK and South Africa, because individuals can purchase their insurance through Discovery and Vitality Health / Life – the Discovery-owned health and life insurance businesses in the UK – and subsequently sign up for the Vitality Programme. By contrast, in the US, companies sign up for the programme and decide what incentives and benefits they would like to offer to their employees.

2.1.1. Vitality's Active Reward and Active Reward with Apple Watch incentives

In order to incentivise physical activity, the Vitality programme offers two specific types of incentives: (1) the weekly Vitality Active Rewards incentive and; (2) the monthly Vitality Active Rewards with Apple Watch benefit. A detailed overview of the differences between the two incentive schemes across the three different countries in our analysis can be found in Table 2.1.

Table 2.1: Overview of Vitality's Active Rewards and Apple Watch benefit for the United Kingdom, United States and South Africa

	United Kingdom	United States	South Africa
Audience	Insurance	Corporate Wellness	Insurance
	Weekly Incentive (Vitality Active Rewards)		
Eligible Population	Private Medical Insurance (PMI) customers: adults who have PMI purchased on their behalf by employers (Only optionality is some large insurers chose not to include rewards). Life customers: individual purchasers of life assurance, who can opt for other products without active rewards	Corporate clients opting into the benefit and offering it to their employee population	To be eligible for the Active Rewards, members need to belong to the Discovery Vitality programme
Launch Date	January 2015 for new business; April 2015 for existing business	Varies by client, though the Active Rewards and Apple Watch benefits are made available to members concurrently	September 2015 to Vitality members
Structure	Attainment of a fixed activity target each week (9 Vitality Points; later increased to 12 points in 2017) unlocks the weekly cinema ticket and drink.	The attainment of a dynamically changing weekly physical activity target (framed as a function of Vitality Points) earns a member a reward. A member's target increases over time if they consistently meet their target and decreases if they fail to do so.	Attainment of a dynamically changing physical activity points target each week to unlock the rewards. The weekly target increases over time if members consistently meet their targets
Example Weekly Rewards	Weekly cinema ticket, plus free Starbucks drink	Vitality Points and Gift Cards awarded on a probabilistic basis	Free coffee, smoothies
Activities Eligible for Active Rewards	Light, Standard, Advanced Workouts	Standard and Advanced Workouts	Light, Standard, Advanced Workouts
Program Changes of Note	Maximum activity points earnable per day moved from 10 to 8 in Q1 2017, and physical activity target was increased to 12 points per week	N/A	Social Rewards ended and Surprise Rewards introduced in October 2017 Surprise Rewards ended and Core rewards mechanism changed to new Active Rewards game board.

	United Kingdom	United States	South Africa
	Monthly Incentive (Vitality Active Rewards with Apple Watch)		
Eligible Population	iOS user (Apple iPhone 5 or higher); Member must have Vitality Plus plan; ~ 538,294 eligible for benefit; of which ~ 215,318 are iOS users	iOS user (Apple iPhone 5 or higher); Employer needs to opt into the benefit, which comes at added cost; ~59,800 eligible for benefit; of which ~ 27,263 are iOS users	iOS user (Apple iPhone 5 or higher); Member must have Discovery Gold Card; ~ 97,000 eligible for benefit; of which ~ 50,535 are iOS users
Launch Date	September 2016 for all eligible Life and individual PMI clients. Employees and their families became eligible at their subsequent policy renewal.	Varies by client, though Active Rewards and Apple Watch benefits are made available to members concurrently	November 2015 to Vitality members
Structure	The attainment of a monthly target (framed as a function of Vitality Points) earns a member discounts on their Apple Watch	The attainment of a fixed monthly target (framed as a function of Vitality Points) earns a member discounts on their Apple Watch	The more weekly targets a member reaches in a month, the higher the discount they unlock on their Apple Watch repayment for that month (e.g. meeting 4 targets unlocks the 100% discount)

Source: Discovery, Vitality
Notes: the penetration of iOS users is based on average iOS penetration in the specific country.

Firstly, Vitality Active Rewards incentivises physical exercise by providing members with the opportunity to earn weekly rewards for attaining physical activity goals. Vitality members eligible for the Active Rewards incentive earn weekly points if they track their physical activity and reach specific thresholds of daily activity. The activity is measured and tracked through a variety of different devices – including pedometers, smart phones and fitness trackers – or members can achieve their activity targets by logging gym attendance or participation in sporting events, such as park runs.[4] Subsequently, based on the consent of the member, this data is transferred to Vitality who converts the activity levels into activity points called Vitality Points. While the activity thresholds vary by country, they are generally divided into three broad activity event categories – **(1) light workout days; (2) standard workout days; and (3) advanced workout days** – each of

4 http://www.parkrun.org.uk/

which is related to a specific number of Vitality Points to be rewarded for each event category. The specific weekly rewards also vary by country, though the relative values of the rewards and the activities required to earn them remain fairly consistent across countries. Examples of weekly rewards include, among others, free coffees, cinema tickets, smoothies or gift cards. [5]

To give a concrete example, to earn rewards from Vitality Active Rewards, such as a coffee or a cinema ticket, members in the UK must achieve a pre-set level of 12 weekly physical-activity points. In the UK, members receive 3 points for a light activity day, 5 points for a standard activity day and 8 points for an advanced activity day. For instance, UK Vitality members can earn the 12 points required for weekly rewards by doing any of the following:

1. Walking 7,000 steps (light activity) four days a week (4 x 3 points)
2. Walking 12,500 steps (advanced activity) in two days (2 x 8 points)
3. Exercising at 60 percent of maximum heart rate for 30 minutes (standard activity) three times a week (3 x 5 points)
4. Burning an average 300 calories for 60 minutes (advanced activity) twice a week (2 x 8 points)
5. Going to the gym three days a week (standard activity) (3 x 5 points)

Overall, while not in the scope of this study and associated with some data limitations, the empirical evidence suggests that the gain-framed incentive Vitality Active Rewards is associated with individuals tracking more physical activity compared to when they participate solely in the Vitality programme (see Box 1 for more detail).

Box 1: The association between participation in Vitality Active Rewards and physical activity

Empirical findings for the United Kingdom and the United States suggest that on average, participating in Vitality Active Rewards is associated with an increase in total tracked activity of about 33 percent (UK: 30.7 percent; US: 37 percent) compared to when participating in the Vitality programme alone, without either activating Active Rewards or taking up the Active Rewards with Apple Watch benefit. However, limitations apply to these estimates, such as limited data availability and potential issues with accurately measuring activity levels of individuals participating in the Vitality programme only and not in one of the two Vitality incentive schemes (Active Rewards and Active Rewards with Apple Watch). Appendix B provides more detail.

Secondly, besides the gain-framed Vitality Active Rewards incentive, the Vitality programme also provides an additional loss-framed incentive scheme called Vitality Active Rewards with Apple Watch for eligible members across different markets. This programme allows them to purchase a desirable market-leading wearable device with incorporated activity tracker (Apple Watch) for a small initial fee, while subsequent monthly repayments for the device are linked to individual physical activity engagement levels over a 24-month period. Depending on the level of activity points a member earns (UK and US), or the number of weekly goals a member achieves per

5 See section 2.1.2 for a more detailed description of the different daily activity levels and event categories.

month (SA), the monthly repayment can be reduced to zero, though even if the member is not engaging in physical activity at all, they would never pay more than the retail cost of the device. Table 2.2 provides an overview of the average monthly repayments according to monthly levels of activity in each of the three countries, and the corresponding overall percentage (%) savings compared to the full retail price of an Apple Watch.

Table 2.2: Average monthly payments for Vitality's Active Rewards with Apple Watch benefit

1. United Kingdom			
Monthly Activity Points	**Pay/Month**	**Pay/2 Years**	**% Saving to Retail Price**
0-39	£12.50	£329.00	0%
40-79	£10	£269.00	18%
80-119	£7.50	£209.00	36%
120-159	£5	£149.00	55%
160	£0	£29.00	91%
2. United States			
Monthly Activity Points	**Pay/Month**	**Pay/2 Years**	**% Saving to Retail Price**
<120	$12.50	$329.00	0%
120-179	$10.00	$269.00	18%
180-249	$6.00	$173.00	47%
>250	$0.00	$29.00	91%
3. South Africa			
Targets Reached Per Month	**Pay/Month**	**Pay/2 Years**	**% Saving to Retail Price**
0	R254	R6,100	0%
1	R254	R6,100	0%
2	R191	R4,575	25%
3	R127	R3,050	50%
4	R0	R 799	87%

Source: Discovery, Vitality
Notes: Cost and savings for the United Kingdom and the United States calculated based on a 38mm Apple Watch Series 3 with a retail price of £329 (UK) and $329 (US) and £29/$29 initial activation fees. Note that while Vitality members are usually offered the latest version of the Apple Watch, the benefit would also allow Vitality members to take up other Apple Watch models, including for instance the Series 1 model with a different pricing structure, however the average discount saving stays constant independent of the model chosen. The average cost and savings for South Africa are calculated based on an initial fee of R 799 and the average value across the different Apple Watch Series' provided to members, with an average retail price of R 6100.

Eligibility for the Vitality Active Rewards with Apple Watch benefit varies slightly across different countries, but generally in order to be eligible the members need to activate Vitality Active Rewards[6] and have an Apple iPhone that is compatible with the Apple Watch. Note that it is important to highlight that the two incentive schemes were introduced across the three different countries in different stages. For instance, for the UK, Active Rewards was introduced at the beginning of 2015, whereas the Active Rewards with Apple Watch benefit was introduced to UK Vitality members in September 2016. In South Africa, Active Rewards was introduced in September 2015 and the Active Rewards with Apple Watch benefit introduced in November 2015. In the United States, Active Rewards and Active Rewards with Apple Watch were made available to Vitality members simultaneously.

2.1.2. Measurement of activity levels in Active Rewards and Active Rewards with Apple Watch

The three broad activity thresholds (e.g. light, standard and advanced activity) can be reached through different types of activity events, including step events (e.g. total number of steps per day), gym events (e.g. a minimum 30-minute stay in a gym), heart-rate events (e.g. reaching a percentage threshold of maximum heart rate); or calorie events (e.g. burning a certain number of calories within a specified time limit). **Here it is important to highlight that the Vitality points structure (predicated on light, standard and advanced activity) adjusts for device variability by ensuring that comparable events have a similar point weighting**. The criteria for each of the event types that qualify for a specific activity threshold and the total number of activity points that can be earned for each by individuals vary across countries. Across the three countries (Panels A to C), Table 2.3 reports the examples of physical activity events that need to be reached per day to qualify for each of the three events in terms of light, standard and advanced daily physical activity. Note that from an analytical perspective, given the differences in how rewards and points for physical activity are calculated across the different countries, it is not possible to directly compare the outcomes between the countries and hence we will analyse each separately. For instance, in the United States, light activity days earn members no specific points towards the benefit, whereas they do provide points in the United Kingdom and South Africa.

6 Except for the United States where Vitality members could in principle be participating in the Active Rewards with Apple Watch benefit without having activated Active Rewards incentive, but it is not very common at all. Furthermore, note that in South Africa, members need to have a Discovery Gold Card.

Table 2.3: Vitality programme light, standard and advanced activity days and types of activity events

Type of events/days	Light activity	Standard activity	Advanced activity
Panel A: United Kingdom			
Step events	7,000 steps tracked in a day	10,000 steps tracked in a day	12,500 steps tracked in a day
Gym event	-	(Partner) gym visit	-
Heart rate event	-	-	30 minutes at 70% maximum heart rate
	-	30 - 59 minutes at 60% maximum heart rate	60 minutes at 60% maximum heart rate
Calorie event	-	30 – 59 minutes at 300 kcals burned per hour (150kcal)	30+ minutes at 600kcal burned per hour (300kcal)
	-	-	60+ minutes at 300kcal burned per hour (300kcal)
Points allocated	**3**	**5**	**8**
Panel B: United States			
Step events	5,000 steps tracked in a day	10,000 steps tracked in a day	15,000 steps tracked in a day
Gym event	-	>= 30-minute gym visit	-
Heart rate event	15 minutes at 60% maximum heart rate	30 minutes at 60% of maximum heart rate	45 minutes at 60% maximum heart rate
Calorie event	Kilocalories (kcals) burned per workout: 100kcal	Kilocalories (kcals) burned per workout: 200kcal	Kilocalories (kcals) burned per workout: 300kcal
Points allocated	**0**	**10**	**15**
Panel C: South Africa			
Step events	5,000-9,999 steps tracked in a day	>10,000 steps tracked in a day	-
Workout event	-	Partner health club workout, Run/Walk For Life, myrun (2.5km)	Parkrun, myrun (5km), Run/Walk For Life (5km+)
Heart rate event	-	>30 minutes at 60-69% of maximum heart rate	-
	-	30-59 minutes at 70-79% of maximum heart rate	>60 minutes at 70-79% of maximum heart rate
	-	-	>30 minutes at >80% of maximum heart rate
Speed event	-	>30minutes running at >5.5km/h or cycling at >10km/h	-

Type of events/days	Light activity	Standard activity	Advanced activity
Verified race events	-	-	e.g. 5-9 kilometre running event, 0.5-1kilometre swimming event; 25 -49 kilometre cycling event.
Points allocated	50	100-200	300

Source: RAND Europe, Discovery, Vitality
Notes: In the United States, Vitality members can earn points through tracking Active Calories, which is specifically measured through the Apple Watch. In South Africa, there is also an additional activity category related to longer verified race events than under "advanced activity" – e.g. >10 kilometre running event, >1.1 kilometre swimming event, >50 kilometre cycling event – which earns members 600 or more points. For the purpose of this analysis, these events are captured in advanced activity.

To give a concrete example in relation to the Vitality Active Rewards with Apple Watch benefit in the UK context, in order to reach the full monthly discount for the Apple Watch (£0 payment), an eligible Vitality member needs to reach 160 activity points a month. The member can reach this by tracking 20 days of advanced activity, including for instance 20 days of 12,500 steps tracked in a day, or 10 days of 12,500 steps tracked and 10 days of 30-minutes exercise at 70 percent maximum heart rate.

3 Research approach: data and methods

In this Chapter we describe in more detail the data used, the statistical methods applied and provide some descriptive statistics for pre-intervention activity levels of the intervention group (Vitality Active Rewards with Apple Watch) and the reference group (Vitality Active Rewards) of this study.

3.1. Data sample and variables

For the purpose of this analysis Vitality has provided anonymised monthly data from its members across three countries – the UK, US and SA. The data includes information about demographics, such as age, gender and the place of residence, and about members' Body Mass Index (BMI). In addition, the data includes a wealth of information about their physical engagement, including the total number of Vitality Points earned each month, as well as the total number of days at which light, standard and advanced activities have been conducted. The activity variables are categorised as days on which an individual has logged and reached the levels of activity described in section 2.1.2, with regards to light, standard or advanced activity.

The dependent variables we explain in our statistical models are:

- Total number of days at which at least a light activity threshold has been met;[7]
- Total number of days a light activity threshold has been met;
- Total number of days a standard activity threshold has been met;
- Total number of days an advanced activity threshold has been met;
- Total number of step event days;
- Total number of heart-rate event days;
- Total number of gym event days;
- Total number of calorie event days.

For the UK, the data is available from 2014 to 2018, whereas for the US and South Africa the available data begins in 2015. The Vitality Active Rewards with Apple Watch benefit was

7 Or in other words the sum of all levels of activity days.

introduced in 2016 and hence there is sufficient data available for most of the individuals in the sample to compare how physical activity levels differ between varying individual uptakes of the Active Rewards incentive and/or the Active Rewards with Apple Watch benefit.

In this analysis the intervention is defined as the moment the individual takes up the Vitality Active Rewards with Apple Watch benefit[8] and for the purpose of this analysis we only include Vitality members that are eligible for the benefit.[9] As we compare the physical-activity-enhancing association of the Active Rewards with Apple Watch benefit against the Active Rewards incentive only we also discard individuals from the sample that are not participating in Active Rewards. In addition, in order to circumvent the issue of attrition, we include only individuals in the sample that are currently still enrolled in the Vitality programme. **Overall, 422,643 individuals participating in the Vitality Active Rewards incentive are included in the analysis, of which in total 91,000 have taken up the Vitality Active Rewards with Apple Watch benefit.** Regarding the specific country samples, in the analytic sample for the UK 238,422 individuals are included, of which 59,237 have taken up the Vitality Active Rewards with Apple Watch benefit. In the US sample, 17,648 individuals are included of which 8,302 have taken up the Vitality Active Rewards with Apple Watch benefit. For the SA sample, 166,573 individuals are included of which 23,461 have taken out the benefit.[10]

3.2. Statistical models

Participation in the Vitality programme is self-selected. Individuals or their employers choose to participate in the Vitality Active Rewards incentive and also choose whether to activate the Vitality Active Rewards with Apple Watch benefit alongside Active Rewards. Furthermore, we would expect that individuals likely differ in characteristics other than taking up the Vitality Active Rewards with Apple Watch benefit, such as their initial levels of activity, and their health and general lifestyle, among others. In order to address this selection problem we apply an individual fixed-effects model. The individual fixed-effects model uses within-individual variations in the uptake of the Vitality Active Rewards with Apple Watch benefit to identify the benefit's association with physical activity enhancement.[11] This approach mitigates to some extent issues related to the selection of individuals from the Vitality population samples into the intervention due to observable or unobservable individual specific components that are constant over time. Time trends and seasonality in physical activity patterns are controlled for with a set of dichotomous variables for each specific month in a given year (or so-called month/year fixed-effects).[12]

8 I.e. the date the Vitality member has ordered the device. Note that the data also includes the date for which the first payment cycle of the Apple Watch starts. However, the payment cycles are delayed so the individual would have already used the device.

9 Eligibility criteria discussed in section 2.1 and outlined in Table 2.1.

10 See Table 3.1 for more details.

11 Note that using an individual fixed-effects model and the fact that individuals take up the VARAW benefit at different points in time, mimics a differences-in-differences (DiD) approach that compares individuals before and after the intervention. One key identification assumption of the DiD estimator is that intervention and reference group have similar trends in the outcome variable for the pre-intervention period, but differential trends in the post-intervention period (Pischke, 2005; Angrist and Pischke, 2013).

12 There are seasonal effects in physical activity, as for instance physical activity levels may be lower in December than in January, with peak levels of physical activity observed in late spring months.

Ideally we would also want to include individual-specific time trends that would control for all time-varying individual (selection-) effects but unfortunately they would be fully collinear with the intervention variable.[13] Nevertheless, we include individual quarterly fixed-effects that at least control for time-varying individual factors on a quarterly basis. Specifically, we estimate the following empirical specification:

$$y_{i,my} = \alpha_i + \gamma_{my} + \partial_{i,qy} + \beta\, VARAW_{i,my} + \varepsilon_{i,my} \quad (1)$$

In this equation, the variables are defined as follows:

- $\mathbf{y}_{i,my}$: denotes the outcome of interest by individual $\boldsymbol{i}$ at month $\boldsymbol{m}$ in year $\boldsymbol{y}$, including for instance the number of days per month with tracked light, standard or advanced levels of activity;
- $\boldsymbol{\alpha_i}$: is an individual-specific time-invariant effect, that allows the comparison over time within the same individual;[14]
- $\boldsymbol{\gamma_{my}}$: are time-variant effects which adjust for time trends such as seasonal monthly effects.[15] Specifically, for the purpose of the analysis we include month/year fixed-effects, which capture a potential trend effect within a specific year;
- $\boldsymbol{\partial_{i,qy}}$: are individual quarterly/year effects that capture a time trend within each individual, controlling for time-varying factor that cannot be controlled for, including for instance, changes in employment, income or changes in family circumstances;[16]
- $\boldsymbol{VARAW_{i,my}}$: is an indicator variable taking the value 1 if individual $\boldsymbol{i}$ has taken up the Active Reward with Apple Watch benefit at and after month $\boldsymbol{m}$. It represents the intervention variable in the analysis (compared to the reference group of individuals participating in Active Rewards only).

Note that equation (1) allows us to identify the size and statistical significance of the association of the uptake of the Vitality Active Rewards with Apple Watch benefit on physical activity, namely β, comparing the same individual before and after the uptake and when participating in Vitality Active Rewards only. This approach aims to take into account other trends that could have led to changes in physical activity. Furthermore, in order to investigate the intervention's association with physical activity across different sub-groups of the Vitality population we build so called 'interaction terms' by building indicator variables taking the value 1 if an individual belongs to a specific at-risk sub-group such as a high BMI group and interact them with the intervention variable $VARAW_{i,my}$. To that end, we also capture the heterogeneity of the associations and statistical significance across different sub-groups.

13 This is because within an individual the intervention variable varies by month/year.

14 Note that the individual fixed-effect absorbs all non-time-varying factors such as gender as well.

15 Note that the data shows that physical activity tends to be lower in the months of November and December and then increasing again in January/February.

16 Note that basically all time-varying factors such as age or length in the policy are absorbed by the quarter-individual fixed-effect and hence cannot be reported separately.

In order to observe the time passage of the association for the Vitality Active Rewards with Apple Watch benefit and physical activity we include indicator variables taking the value 1 two months before the intervention and six months after the intervention and one indicator variable taking the value 1 for all months after month 6. Letting $\boldsymbol{k}$ be the month at which the Active Rewards with Apple Watch benefit is taken up by individual $\boldsymbol{i}$, we estimate the following empirical specification:

$$y_{i,my} = \alpha_i + \gamma_{my} + \partial_{i,qy} + \sum_{j=-p}^{q} \beta_j \, VARAW_{i,my}(t = k + j) + \varepsilon_{i,my} \quad (2)$$

Instead of a single intervention variable we also include $\boldsymbol{p}$ leads and $\boldsymbol{q}$ lags of the intervention. β_j represents the coefficient on the $\boldsymbol{jth}$ lead or lag. Note that if the coefficients on all leads are zero, $\beta_j = 0, \forall j < 0$, then individuals that take up the Vitality Active Rewards with Apple Watch benefit do not have a different trend in physical activity before the uptake of the benefit than other individuals that participate in Vitality Active Rewards only. This is important as it could be that individuals taking up the Active Rewards with Apple Watch benefit could have decided to do more physical activity anyway, even in the absence of the intervention.[17] Moreover, the $\beta_j, \forall j \geq 0$ measure the time-varying effect of the intervention and test whether the effect of the uptake of the Active Reward with Apple Watch benefit persists over time.

In this analysis, the dependent variables are measured in days of activity per month and hence take only non-negative integer values. This type of data is generally classified as count data and subsequently tends to follow a Poisson distribution. For this reason we use Poisson regression models with fixed-effects instead of linear regression models. For each regression model we calculate clustered standard errors at the insurance policy level.[18] Results are reported at the 0.1 % significance level ($p<0.001$). All statistical analyses were conducted in Stata 15.[19]

3.3. Limitations and sensitivity analysis

While this analysis is based on a large population observational dataset across Vitality programme members of three different countries, and hence increases significantly the sample size and allows the generalisability of the findings to a larger population than previous studies, it has to be highlighted that the Vitality population may not be representative of the full population of a country itself. Furthermore, in some countries eligibility to some of the incentives offered might be restricted towards a more wealthy population, for instance South Africa, where eligibility to Vitality Active Rewards and Active Rewards with Apple Watch depends on possessing a credit card. That means the estimated associations from this study would not be applicable to a randomly picked person from the full UK, US or SA population.

Furthermore, as noted earlier, it is important to highlight that independent of participating in the Active Rewards and Active Rewards with Apple Watch benefits, Vitality programme members

17 Note that in a traditional DiD setting, this tests for the key assumption for common pre-intervention trends. The inclusion of leads and lags of the intervention variable allows testing this assumption.

18 Note that individuals can take up their own insurance or are covered under the scheme of the employer, resulting that some individuals are covered within the same insurance policy.

19 https://www.stata.com.

earn access to an assortment of longer term rewards – ranging from discounts on healthy food purchases to discounted flights, amongst others – for engaging in validated healthy lifestyle activities, such as health check-ups, healthy food purchases and tracking their activity through various wearable devices. At baseline, tracking activity is one channel through which a healthy lifestyle can be documented. The study authors believe that participating in the Vitality Active Rewards or Active Rewards with Apple Watch programmes incentivises individuals to track their physical activity levels in a more systematic manner and hence more accurately as when participating in none of these two incentives. Consequently, in the interests of robustness, the main scope of this study is to assess whether the combined impact of Vitality's Active Rewards with Apple Watch programme leads to higher rates of activity relative to those engaging in the Vitality Active Rewards incentive alone. Nevertheless, using the same data samples and methodology as described in sections 3.1 and 3.2, Appendix B provides estimates for the association between physical activity and participating in Active Rewards only compared to being a Vitality programme member but not participating either in Active Rewards or Active Rewards with Apple Watch. Given that activity data pre-Active Rewards was available only for the UK and US samples, and the other data limitations highlighted above regarding the tracked activity levels, the findings presented in Appendix B need to be interpreted and applied with some caution.

Additionally, as described in section 2.1, the categories of activity days are based on points collected from different types of tracked activity events, including step, heart rate, gym and calorie events. One could argue that if the uptake of the Vitality Active Rewards with Apple Watch benefit indeed leads to an increase in tracked physical activity, this increase could just emerge from the fact that the Apple Watch is measuring activity better than the device previously used by the individual to track activity (e.g. pedometer or smart phone), or that the loss-framed incentive just makes the individual better aware of tracking the activity more accurately. Generally, one would expect that the issue of device variability is minimal as the Vitality Points structure reported in Table 2.3 already adjusts for device variability since comparable workouts or activity events (e.g. light, standard and advanced activity) have a similar point weighting. However, in order to refine the analysis further and check for the robustness of the results, we consider two sub-samples in each of the three countries: (1) individuals who, prior to the intervention, utilized a heart-rate tracking device; and (2) individuals who were gym members. In the former scenario, since heart rate is a consistent measure pre- and post-intervention, we are limiting the device impact on the outcome measures; in the latter scenario, we are taking into account externally verified activity events and hence any increase in activity compared to pre-intervention is more likely driven by an underlying behaviour change rather than a device effect. Unfortunately, the data does not include whether or what type of fitness tracker the individual used before the uptake of the Active Rewards with Apple Watch benefit. What we do have though is the number of heart-rate events measured and, given that heart-rate activity can only stem from an accurate fitness tracker with heart-rate functionality, we assume that if an individual has logged at least one heart-rate event pre-intervention they would have had access to such a device. While not a perfect indicator, it serves as a proxy for previous heart-rate fitness-tracker ownership. Hence, if the increased activity levels stemmed solely from the fact that the Apple Watch allows individuals to track activity more accurately then we would hypothesise that we would not observe uplift in activity levels for the sub-population with at least one heart-rate event pre-intervention. In a similar way, recorded gym events are verified by the gym facility in which the individual is conducting the exercise. So independent of the tracker device, an increase in gym visits after the uptake of the Active Rewards with Apple Watch benefit compared to the level of gym visits of participating in Active Rewards only would suggest a behaviour change. In the case of gym events it has to be highlighted that the Apple Watch would allow individuals to perform different types of exercises that can be tracked that do not have to be in the gym (e.g. outdoor runs or cycling). As a further robustness check we run the analysis on a sub-sample of individuals only that had at least one gym event pre-intervention.

3.4. Descriptive statistics: characteristics between Active Rewards with Apple Watch and Active Rewards only groups

Table 3.1 reports the differences across characteristics for the reference group (VAR only) and the intervention group (VARAW) across the three countries included in the analysis.

Table 3.1: Characteristics at baseline: VARAW (pre-intervention) and VAR only

Panel A: United Kingdom (N=238,422)										
	VAR only (N=179,185)					VARAW (N=59,237)				
Days of activity:	mean	sd	median	min	max	mean	sd	median	min	max
Total	**12.04**	(8.69)	11.00	0	31	**13.17**	(8.82)	13.00	0	31
Light	**4.02**	(4.20)	3.00	0	31	**4.26**	(4.05)	3.00	0	29
Standard	**3.82**	(3.98)	2.00	0	31	**3.46**	(3.71)	2.00	0	30
Advanced	**3.60**	(5.41)	1.00	0	31	**4.33**	(5.82)	2.00	0	31
Step	**10.06**	(9.33)	8.00	0	31	**11.27**	(9.33)	10.00	0	31
Heart rate	**1.03**	(2.87)	0.00	0	31	**1.01**	(2.91)	0.00	0	31
Gym	**2.02**	(4.11)	0.00	0	31	**1.96**	(4.22)	0.00	0	31
Calorie	**0.32**	(1.66)	0.00	0	31	**0.31**	(1.62)	0.00	0	31
BMI	**28.83**	(12.06)	25.10	14	65	**25.85**	(5.54)	24.90	14	65
Age	**39.81**	(10.11)	38.00	18	90	**38.37**	(8.51)	38.00	18	78
Male	**0.55**	(0.50)	1.00	0	1	**0.57**	(0.49)	1.00	0	1
Panel B: United States (N=17,648)										
	VAR only (N=9,346)					VARAW (N=8,302)				
Days of activity:	mean	sd	median	min	max	mean	sd	median	min	max
Total	**14.13**	(11.48)	15.00	0	31	**15.26**	(10.92)	17.00	0	31
Light	**6.64**	(7.12)	4.00	0	31	**7.51**	(6.95)	6.00	0	29
Standard	**5.31**	(6.43)	3.00	0	31	**5.40**	(6.35)	3.00	0	31
Advanced	**2.18**	(4.88)	0.00	0	31	**2.35**	(5.11)	0.00	0	31
Step	**10.26**	(10.51)	7.00	0	31	**11.18**	(9.98)	9.00	0	31

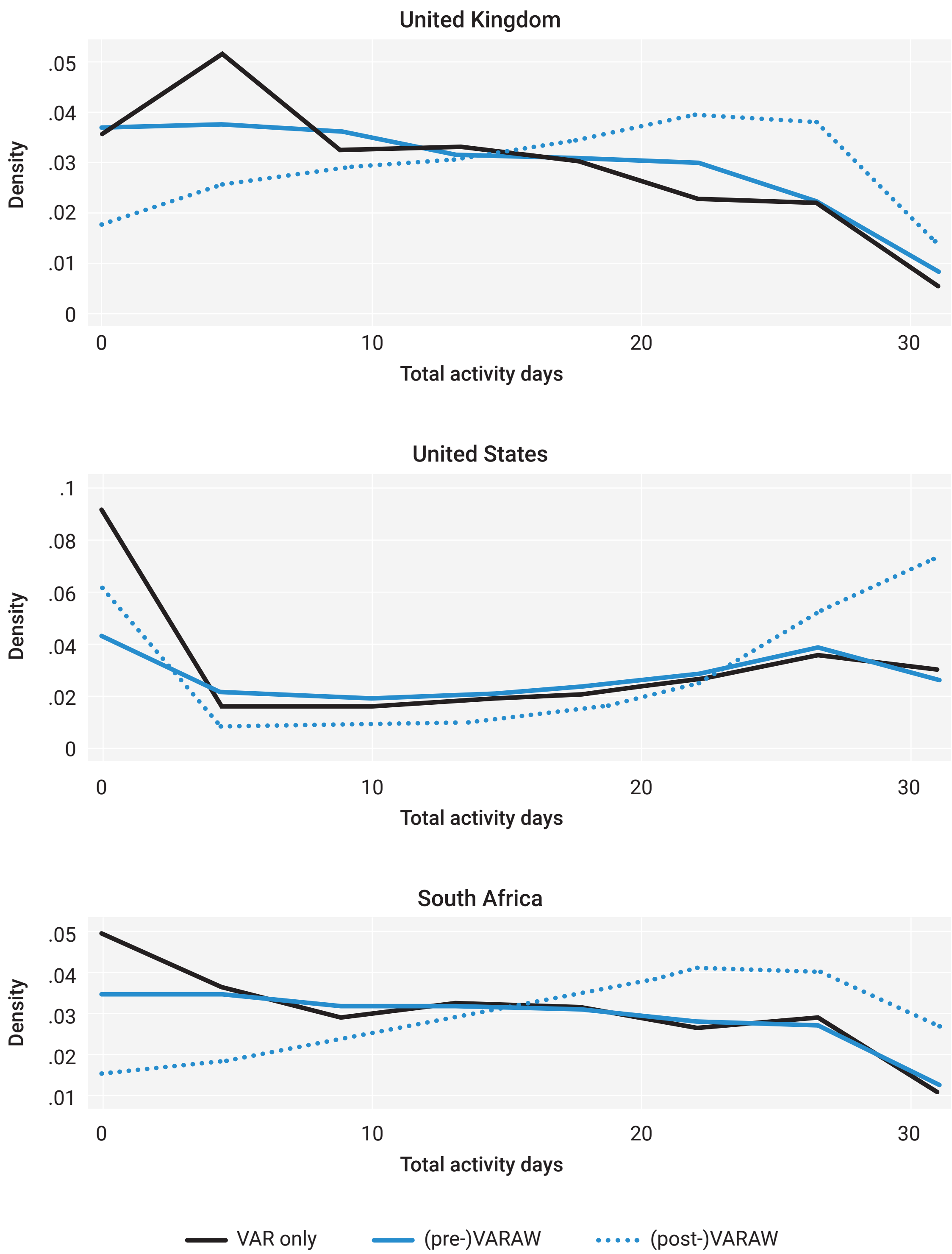
Heart rate	**0.06**	(0.60)	0.00	0	21	**0.05**	(0.55)	0.00	0	15
Gym	**1.71**	(4.21)	0.00	0	31	**1.68**	(4.04)	0.00	0	31
Calorie	**0.62**	(2.85)	0.00	0	31	**0.84**	(3.65)	0.00	0	31
BMI	**27.76**	(6.33)	26.40	14	65	**28.45**	(6.29)	27.30	14	64
Age	**40.69**	(10.46)	40.00	19	81	**36.94**	(9.40)	36.00	19	67
Male	**0.37**	(0.48)	0.00	0	1	**0.30**	(0.46)	0.00	0	1
Panel C: South Africa (N=166,573)										
	VAR only (N=143,112)					**VARAW (N=23,461)**				
Days of activity:	**mean**	**sd**	**median**	**min**	**max**	**mean**	**sd**	**median**	**min**	**max**
Total	**13.68**	(9.32)	13.00	0	31	**13.90**	(9.22)	13.00	0	31
Light	**5.21**	(5.86)	3.00	0	31	**4.36**	(5.22)	2.00	0	31
Standard	**6.46**	(7.30)	4.00	0	31	**7.71**	(7.64)	6.00	0	31
Advanced	**2.00**	(3.42)	1.00	0	31	**1.83**	(3.13)	1.00	0	31
Step	**2.09**	(3.64)	0.00	0	31	**1.57**	(2.98)	0.00	0	31
Heart rate	**0.21**	(0.83)	0.00	0	30	**0.18**	(0.84)	0.00	0	20
Gym	**2.23**	(3.36)	0.00	0	29	**2.68**	(3.61)	1.00	0	24
Calorie	**0.01**	(0.17)	0.00	0	20	**0.03**	(0.42)	0.00	0	25
BMI	**26.28**	(5.04)	25.50	14	65	**26.35**	(4.57)	25.77	14	65
Age	**38.20**	(11.06)	36.00	15	94	**37.97**	(9.82)	36.00	19	80
Male	**0.48**	(0.50)	0.00	0	1	**0.58**	(0.49)	1.00	0	1

Notes: Entries depict mean days of activity, standard deviation (sd), median minimum (min) and maximum (max) value of each of the variables pre-uptake of the Vitality Active Rewards with Apple Watch (VARAW) group (intervention) compared to the Vitality Active Rewards (VAR) group only (reference group).

Generally, as indicated earlier, the Vitality members that take up the Active Rewards with Apple Watch benefit (intervention group) differ in some characteristics compared to the members that participate only in Active Rewards (reference group). For instance, across the three countries individuals in the intervention group track on average more total activity days, especially among advanced activity days, specifically in the UK and the US. The individuals in the intervention group also tend to be slightly younger on average than individuals in the reference group.

As a descriptive analysis we also report the kernel densities for the total number of activity days across the three countries for: (1) the reference group (VAR only); (2) the intervention group before the intervention (pre-VARAW); and (3) the intervention group after the intervention (post-VARAW). Across the US and SA sample it is evident that pre-intervention the VARAW group tends to track zero activity days on a less frequent basis, whereas these figures are relatively equal for the UK sample. Interestingly, when looking at the distributions in Figure 3.1 it is evident that post-intervention the VARAW group tracks more activity days than before the uptake of the Active Rewards with Apple Watch benefit. In what follows we aim to quantify the magnitude and statistical significance of the shift in more physical activity for the intervention group.

Figure 3.1: Distribution of total activity days per month (VAR only; pre-VARAW; post-VARAW)



Notes: plots depict the Epanechnikov kernel density estimates by country for the total number of activity days per month. Entries reported for reference group (VAR only) and intervention group (VARAW) pre-and post-intervention.

4 Results and discussion

In this Chapter we present the empirical findings regarding the association between the uptake of the Vitality Active Rewards with Apple Watch benefit and the engagement in physical activity. As previously described, we compare how the tracked physical activity levels of individuals that take up the benefit (intervention group) change compared to the tracked physical activity levels of individuals that participate in Vitality Active Rewards only (reference group). The Chapter starts with reporting the parameter estimates for β from estimating equation (1) separately for the three country samples, where we also report the estimates for different subgroups. Subsequently we report the parameter estimates for the β_j's from estimating equation (2) which provides a test for the time persistence of the associations.

4.1. The associations between the Vitality Active Rewards with Apple Watch benefit and physical activity

4.1.1. Analysing the associations for the full samples

Table 4.1 reports the estimated parameters for estimating equation (1) across the three country samples. In essence, the parameters reported show the average change in the number of physical activity days per month for individuals taking up the Vitality Active Rewards with Apple Watch benefit (intervention) compared to if the individual only participated in the Vitality Active Rewards incentive (reference).

The parameter estimates in Table 4.1 suggest that taking up the Apple Watch benefit leads to a higher number of tracked activity days per month. The magnitude of the associations is broadly comparable across the three country samples, and interestingly, the largest relative change is reported among advanced activity days. When we look at the different event types across countries, the findings for the UK and SA sample suggest an increase in step, heart rate and gym days, whereas the findings for the US sample suggest an increase in step, gym and calorie days.

Table 4.1: Parameter estimates for the associations between Vitality Active Rewards with Apple Watch benefit and physical activity

	United Kingdom		United States		South Africa	
Dependent variables:	beta	se	beta	se	beta	se
Total activity days	0.245	**(0.011)**	0.267	**(0.025)**	0.366	**(0.008)**
Light activity days	0.168	**(0.006)**	0.176	**(0.034)**	0.397	**(0.012)**
Standard activity days	0.224	**(0.010)**	0.311	**(0.052)**	0.263	**(0.010)**
Advanced activity days	0.318	**(0.019)**	0.421	**(0.052)**	0.537	**(0.013)**
Step days	0.245	**(0.011)**	0.077	**(0.015)**	0.695	**(0.021)**
Heart rate days	0.443	**(0.030)**	-0.022	(0.246)	1.037	**(0.057)**
Gym days	0.174	**(0.008)**	0.175	**(0.051)**	0.162	**(0.012)**
Calorie days	-0.031	(0.017)	0.079	**(0.016)**	0.857	**(0.171)**
No of observations	3,109,891		189,943		1,981,207	

Notes: standard errors (se) clustered reported (insurance policy level). Statistically significant parameters have a boldface marked standard error (p<0.001). The beta parameter estimates are from an individual fixed-effects Poisson regression estimating equation (1). The dependent variables are the number of activity days per month in total and by level of intensity (light, standard, advanced) or event type (step, heart rate, gym, calorie). The reported coefficients show the average differences in physical activity for individuals taking up the Vitality Active Rewards with Apple Watch benefit compared to if the individual would only participate in the Vitality Active Rewards incentive. Note that in the US, heart rate data from the Apple Watch is not used, and hence one would not expect an increase in this parameter for the US sample.

We translate the coefficients for the estimated beta's from equation (1) into a percentage change and corresponding additional days of activity across the three countries, as reported in Table 4.2.[20]

Table 4.2: Changes in activity levels after uptake of the Vitality Active Rewards with Apple Watch benefit

	United Kingdom		United States		South Africa	
Dependent variables:	percent	days	percent	days	percent	days
Total activity days	27.7%	3.6	30.6%	4.7	44.2%	6.1
Light activity days	18.3%	0.8	19.3%	1.4	48.8%	2.1
Standard activity days	25.1%	1.1	36.5%	2.0	30.1%	2.3
Advanced activity days	37.4%	1.6	52.4%	1.2	71.1%	1.3

Notes: percentage changes calculated by transforming beta coefficients reported in Table 4.1 by $(e^{\beta} - 1) * 100$ *; additional days calculated by applying percentage change of activity to average days of activity per month for the VARAW intervention group pre-intervention reported in Table 3.1.*

20 Note that to translate the beta coefficients into a percentage change one has to transform it as follows: $(e^{\beta} - 1) * 100$. In addition, to translate the percentage change into additional days we use the baseline (pre-intervention) characteristics for the VARAW intervention group which are reported in Table 3.1.

Across the three country samples, on average the findings suggest that an individual taking up the Vitality Active Rewards with Apple Watch benefit tracks on average 4.8 days per month (or about 34 percent) more activity than the individual who participates in Active Rewards only. By country, the total number of activity days per month increased on average by 44.2 percent in South Africa, 30.6 percent in the United States and by 27.7 percent in the United Kingdom. This translates into 6.1 additional days of exercise per month for the SA sample, 4.7 days per month of additional exercise in the US sample and 3.6 days per month for individuals in the UK sample. The variation of the associations across countries may be due to a combination of the selectiveness of the populations taking up the Vitality Active Rewards with Apple Watch benefit, but also due to differences in incentive structures.

Looking at the intensity of the performed activity, the largest relative change in percent for advanced activity days is also observed for South Africa (71.1 percent), followed by the United States (52.4 percent) and the United Kingdom (37.4 percent). However, given that at baseline individuals in the UK sample already track on average slightly more advanced activity days compared to individuals in the US and SA sample, the absolute change in additional advanced activity days is larger, with 1.6 additional days for the UK, compared to 1.3 days (SA) and 1.2 days (US) respectively.

4.1.2. Analysing the associations for sub-samples: sensitivity analyses

As outlined in section 3.3 above, one could argue that the increase in tracked physical activity stems from the fact that the Apple Watch is just measuring activity better than the device previously used by the individual to track activity (e.g. pedometer or smart phone), or that the financial incentive to perform physical activity just makes the individual more aware of tracking the activity more accurately. As described earlier, the Vitality Points structure – which is predicated on light, standard, and advanced activity days – already adjusts for device variability since comparable workouts or activity events have a similar points weighting. However, in order to refine this further, we consider two sub-samples: (1) individuals who, prior to the uptake of the Active Rewards with Apple Watch benefit, utilized a heart-rate tracking device and (2) individuals who were gym members. Both should eliminate to some extent any potential device effect associated with the Apple Watch. The parameter estimates for estimating equation (1) for these two sub-samples are reported in Table 4.3 and 4.4. In both tables, Panel B reports the pre-intervention average days of activity for the group that takes up the Vitality Active Rewards with Apple Watch benefit. Not surprisingly, on average the individuals in the two sub-samples are somewhat more active at baseline compared to the full samples in each country, especially when we consider the average number of advanced activity days per month. Hence we would expect the relative coefficients to be smaller compared to the full samples, because the individuals in the sub-sample have already higher absolute levels of baseline activity before uptake of the Vitality Active Rewards with Apple Watch benefit.

Table 4.3: Changes in activity levels after uptake of the Vitality Active Rewards with Apple Watch benefit, at least one heart-rate event day pre-intervention

	United Kingdom		United States		South Africa	
Panel A: Coefficients from regression analysis						
Dependent variables:	**beta**	**se**	**beta**	**se**	**beta**	**se**
Total activity days	0.106	***(0.007)***	0.235	*(0.056)*	0.129	***(0.012)***
Light activity days	0.051	***(0.006)***	0.079	*(0.119)*	0.112	*(0.020)*
Standard activity days	0.109	***(0.007)***	0.365	***(0.076)***	0.110	*(0.025)*
Advanced activity days	0.147	***(0.014)***	0.314	***(0.061)***	0.194	***(0.023)***
Panel B: Pre-intervention average days for VARAW intervention group						
	mean	**sd**	**mean**	**sd**	**mean**	**sd**
Total activity days	13.5	*(8.9)*	19.4	*(10.1)*	16.6	*(8.9)*
Light activity days	4.4	*(3.9)*	6.1	*(5.1)*	5.1	*(5.7)*
Standard activity days	3.5	*(3.5)*	5.8	*(5.8)*	7.6	*(6.9)*
Advanced activity days	4.8	*(5.9)*	7.4	*(6.4)*	3.9	*(4.7)*
No of observations	2,684,887		20,844		1,760,470	

Notes: standard errors (se) clustered reported (insurance policy level). Statistically significant parameters have a bold-face marked standard error (p<0.001). Panel A reports the beta parameter estimates are from an individual fixed-effects Poisson regression estimating equation (1). The dependent variables are the number of activity days per month in total and by level of intensity (light, standard, advanced). The reported coefficients show the average differences in physical activity for individuals taking up the Vitality Active Rewards with Apple Watch (VARAW) benefit compared to if the individual only participated in the Vitality Active Rewards incentive. Sample includes only individuals with at least one tracked heart rate event prior the uptake of the benefit. Panel B reports the pre-intervention average days for the intervention group (VARAW), including the mean days (mean) and corresponding standard deviation (sd).

When we look at the parameter estimates for the sub-groups reported in Panel A of both tables, we can discard the notion that the increase in activity levels after the uptake of the Vitality Active Rewards with Apple Watch benefit is solely due to a device effect. Indeed, across both sub-samples, activity levels tend to increase. Specifically, as reported in Table 4.4 the total number of gym days increases across all three country samples. For the UK sample the increase is 9.8 percent, for the US sample 8 percent and for the SA sample 10.5 percent.

Overall, as expected, due to the selected sample of initially already more active individuals, the magnitude of the associations is somewhat smaller compared to the full sample but in most cases they are statistically significant from zero.

Table 4.4: Changes in activity levels after uptake of the Vitality Active Rewards with Apple Watch benefit, at least one gym event day pre-intervention

	United Kingdom		United States		South Africa	
Panel A: Coefficients from regression analysis						
Dependent variables:	beta	se	beta	se	beta	se
Total activity days	0.198	***(0.012)***	0.232	*(0.022)*	0.252	***(0.009)***
Gym days	0.094	***(0.008)***	0.077	***(0.013)***	0.100	***(0.012)***
Light activity days	0.212	***(0.015)***	0.164	*(0.039)*	0.417	***(0.016)***
Standard activity days	0.134	***(0.010)***	0.218	***(0.041)***	0.144	***(0.010)***
Advanced activity days	0.344	***(0.026)***	0.437	***(0.079)***	0.488	***(0.018)***
Panel B: Pre-intervention average days for VARAW intervention group						
	mean	sd	mean	sd	mean	sd
Total activity days	12.8	*(8.5)*	16.4	*(10.4)*	15.8	*(8.9)*
Gym days	4.9	*(5.5)*	3.0	*(5.0)*	2.2	*(3.4)*
Light activity days	3.3	*(3.9)*	7.6	*(6.7)*	5.2	*(5.9)*
Standard activity days	3.6	*(4.3)*	6.5	*(6.6)*	6.5	*(7.3)*
Advanced activity days	2.6	*(4.5)*	2.2	*(4.8)*	2.0	*(3.4)*
No of observations	2,670,371		104,421		1,860,184	

Notes: standard errors (se) clustered reported (insurance policy level). Statistically significant parameters have a boldface marked standard error ($p<0.001$). Panel A reports the beta parameter estimates are from an individual fixed-effects Poisson regression estimating equation (1).The dependent variables are the number of activity days per month in total and by level of intensity (light, standard, advanced) or type (gym event). The reported coefficients show the average differences in physical activity for individuals taking up the Vitality Active Rewards with Apple Watch (VARAW) benefit compared to if the individual only participated in the Vitality Active Rewards incentive. Sample includes only individuals with at least one tracked gym event prior to the uptake of the benefit. Panel B reports the pre-intervention average days for the intervention group (VARAW), including the mean days (mean) and corresponding standard deviation (sd).

4.1.3. Analysing the associations for sub-samples: the obese and inactive population

In order to test whether the Vitality Active Rewards with Apple Watch benefit also induces behavioural change in at-risk populations we investigate a specific sub-group of relatively at-risk individuals, which is defined as those individuals from the Vitality population that have a BMI over 30 and are in the lowest quartile of pre-treatment recorded activity.[21] Table 4.5 reports the parameter estimates from estimating equation (1) with the main intervention variable $VARAW_{i,my}$ and the interaction term of this variable with an indicator taking the value 1 if an individual belongs to the at-risk group.

21 Counted as total number of days tracking any activity.

Table 4.5: Changes in activity levels after uptake of the Vitality Active Rewards with Apple Watch benefit, at-risk population (BMI > 30 & inactive) vs. not-at-risk population (BMI <=30 & active)

	United Kingdom		United States		South Africa	
Panel A: Coefficients from regression analysis (BMI <=30 & active)						
	beta	se	beta	se	beta	se
Total activity days	0.227	***(0.009)***	0.254	***(0.023)***	0.343	***(0.007)***
Light activity days	0.152	***(0.006)***	0.153	***(0.031)***	0.372	***(0.012)***
Standard activity days	0.211	***(0.009)***	0.304	***(0.050)***	0.244	***(0.010)***
Advanced activity days	0.308	***(0.017)***	0.420	***(0.049)***	0.523	***(0.013)***
Panel B: Coefficients from regression analysis (BMI > 30 & inactive)						
	beta	se	beta	se	beta	se
Total activity days	0.955	***(0.033)***	1.117	***(0.172)***	0.739	***(0.042)***
Light activity days	0.922	***(0.053)***	1.296	***(0.113)***	0.641	***(0.058)***
Standard activity days	0.771	***(0.043)***	1.362	***(0.267)***	0.994	***(0.076)***
Advanced activity days	1.388	***(0.059)***	0.152	*(0.598)*	0.371	***(0.066)***
Panel C: Pre-intervention average days (BMI >30 & inactive)						
	mean	sd	mean	sd	mean	sd
Total activity days	3.6	*(3.6)*	0.9	*(2.1)*	4.5	*(5.0)*
Light activity days	1.5	*(2.1)*	0.6	*(1.4)*	2.2	*(3.3)*
Standard activity days	0.5	*(1.0)*	0.2	*(0.8)*	1.5	*(3.0)*
Advanced activity days	0.6	*(1.4)*	0.1	*(0.8)*	0.9	*(1.5)*
Share full sample	*7%*		*13%*		*4%*	
% uptake VARAW benefit	*6%*		*10%*		*12%*	
No of observations	3,109,891		189,943		1,981,207	

Notes: standard errors (se) clustered reported (insurance policy level). Statistically significant parameters have a boldface marked standard error (p<0.001). Panel A and B report the beta parameter estimates are from an individual fixed-effects Poisson regression estimating equation (1) using an interaction term for the sub-group. The dependent variables are the number of activity days per month in total and by level of intensity (light, standard, advanced) The reported coefficients show the average differences in physical activity for individuals taking up the Vitality Active Rewards with Apple Watch (VARAW) benefit compared to if the individual only participated in the Vitality Active Re-wards incentive. Sample includes only individuals with at least one tracked gym rate event prior to the uptake of the benefit. Panel B reports the pre-intervention average days for the intervention group (VARAW), including the mean days (mean) and corresponding standard deviation (sd).

Note that Panel C of Table 4.5 reports the average characteristics of the at-risk group pre-intervention. Overall, as expected, this sub-population is much less active on average than individuals in the full sample. For instance, on average they track 3.6 activity days per month in the UK sample, 0.9 activity days in the US sample and about 4.5 total activity days per month on average in the SA sample. Across the three data samples, this relative risk population represents about 7 percent of the UK sample, 13 percent of the US sample and 4 percent of the SA sample.

When we compare the uptake rate of the Vitality Active Rewards with Apple Watch benefit for this sub-population compared to the full sample we observe that the rate is lower for the UK and US sample. For instance within the UK sample, 6 percent of this at-risk population takes up the benefit compared to 25 percent for the full sample. In the US, 10 percent take up the benefit in this group compared to 47 percent for the full US sample. In the SA sample, the uptake rate of the benefit is 12 percent which is slightly below the overall uptake rate of 14 percent.

Panel B of Table 4.5 reports the parameter estimates of the intervention variable for the at-risk sub-group. Overall, the relative magnitude of the association is much larger compared to the not-at-risk group (Panel A of Table 4.5). For instance, on average this sub-group in the UK sample increases the number of tracked activity days per month by about 160 percent.[22] In the US sample the same group increases the total number of tracked activity days per month by about 200 percent. In the SA sample, the overall relative magnitude of the association for this sub-group is smaller, with an increase of about 109 percent. If we translate this into additional days, taking into account the pre-intervention days for this sub-group reported in Panel C, the average increase for the UK sample is about 5.7 days of activity per month, for the US sample an increase of 1.8 days per month and for the SA sample, the average increase in days corresponds to 4.5 days per month. Across the three country samples, the relative increase in activity levels can be observed mainly across light and standard activity days, except for the UK sample, where this sub-population also increases the number of advanced activity days per month, by about 300 percent, corresponding to an additional 1.8 advanced activity days per month on average.

In summary, as we would expect for a more inactive sub-population, the uptake of the Vitality Active Rewards with Apple Watch benefit is lower compared to the full sample but once this population has taken up the benefit, the relative increase in physical activity levels is on average larger than for the full sample.

4.2. Testing the persistence of the associations between the Vitality Active Rewards with Apple Watch benefit and physical activity over time

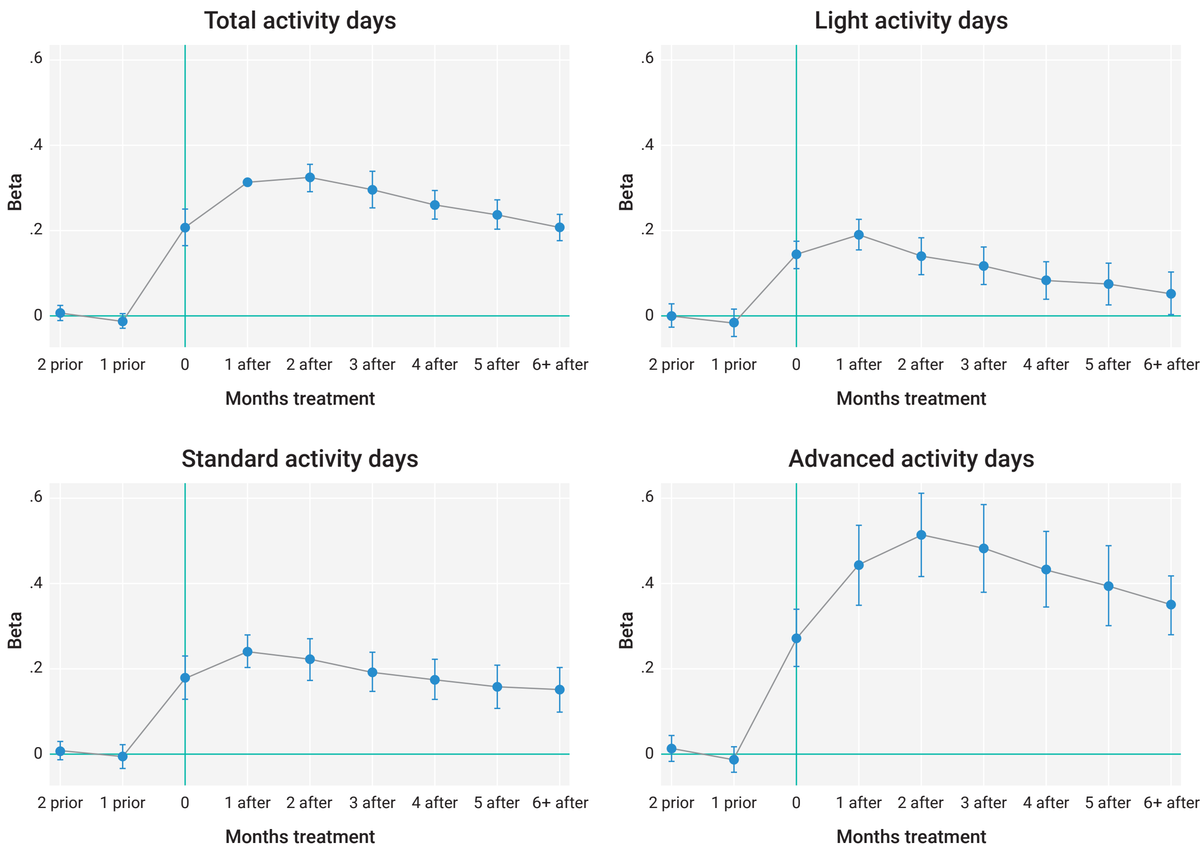
In this section we present the time trends of the association between the Vitality Active Rewards with Apple Watch benefit and increased physical activity levels during the period of the intervention. Figures 4.1 to 4.3 depict the findings of estimating equation (2) with fixed-effects Poisson regression models. Each data point represents the parameter estimate for the lead and lag indicator variables of the intervention variable $VARAW_{i,my}$ for 1 and 2 month prior to the uptake of the benefit, and incrementally between months 0 to 5 and 6 months and beyond post-intervention. Looking at the estimated coefficients for the beta's for the 1 and 2 month lead indicators across the three country samples, the findings suggest that there is no statistically

22 Calculated as: $(e^{0.955} - 1) * 100$.

significant different trend pre-intervention between individuals in the intervention group and the reference group (Vitality Active Rewards only).

However, the parameter estimates presented in Figures 4.1 to 4.3 suggest that there is indeed a positive association between the uptake of the benefit and persistent and sustained improvements in physical activity levels across the three country samples. Looking at the trends over time, for instance for the UK, we find in Figure 4.1 that the overall magnitude of the effect decreases slightly over time but sustains over time. We also observe that on average there is an increase in light activity at the beginning but this becomes not statistically different from zero in the longer run. However, there is a relatively strong increase in the total number of advanced activity days which peaks after two months into the uptake of the benefit and slightly decreases thereafter.

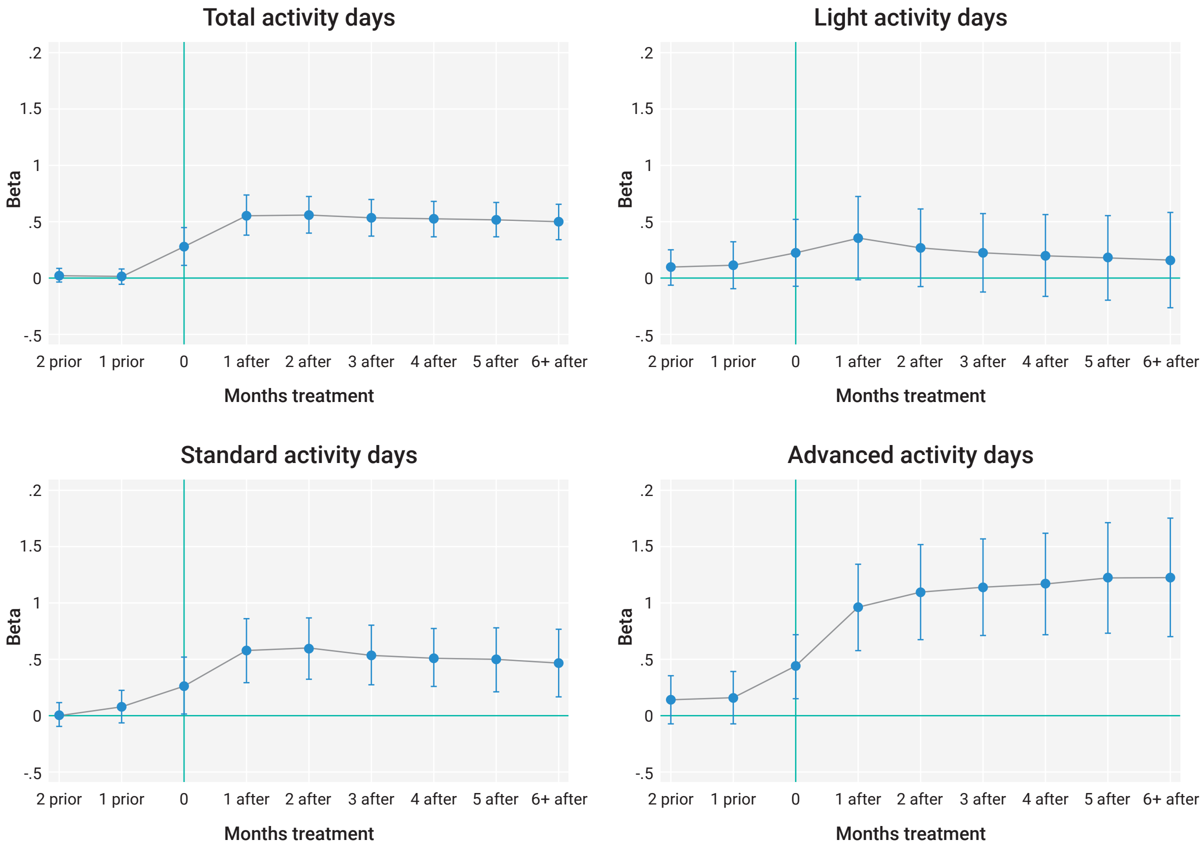
Figure 4.1: Time passage of the association between the Vitality Active Rewards with Apple Watch benefit and physical activity, United Kingdom



Notes: figures report coefficients of estimating equation (2) with fixed-effects Poisson regression and clustered standard errors (insurance policy level); significance levels reported at the p<0.001 level. Reported are the associations for 1 and 2 months prior to uptake of the Vitality Active Rewards with Apple Watch benefit, months 0 to 5 after uptake and 6 months and forward. N=3,109,891.

Figure 4.2 reports the time trend for the positive association between the uptake of the Vitality Active Rewards with Apple Watch benefit and levels of physical activity for the US sample. We observe an immediate uplift in the total number of activity days after the uptake of the benefit which stays fairly constant after 1 month post-uptake. Interestingly, we observe only a very short statistically significant increase in the number of tracked light activity days which flats out afterwards. This can be explained by the fact that in the US light activity days are not rewarded with Vitality Points within the Active Rewards with Apple Watch context. This is in contrast with standard and advanced activity days which tend to sustain (standard activity) or even increase (advanced activity) over time after uptake of the benefit. This trend may suggest that individuals increase their levels of intensity of the exercise events over time.

Figure 4.2: Time passage of the association between the Vitality Active Rewards with Apple Watch benefit and physical activity, United States

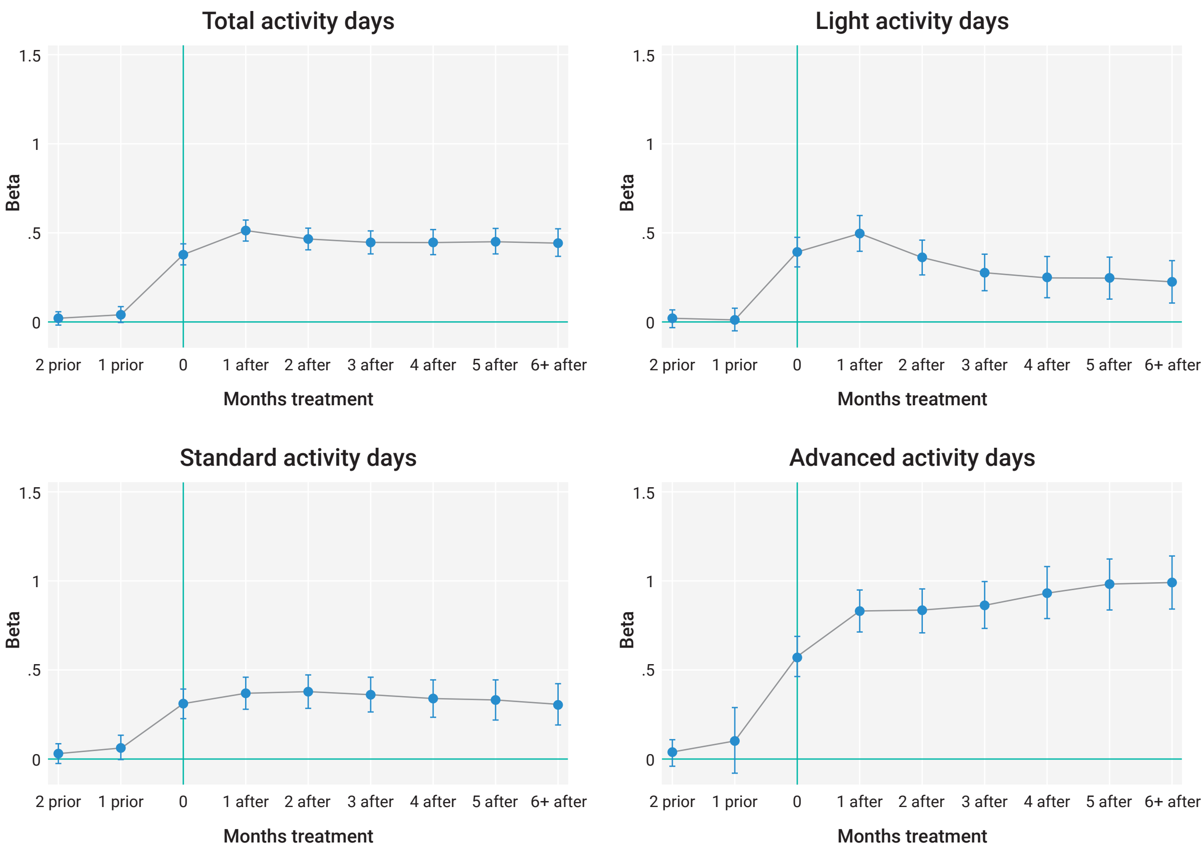


Notes: figures report coefficients of estimating equation (2) with fixed-effects Poisson regression and clustered standard errors (insurance policy level); significance levels reported at the p<0.001 level. Reported are the associations for 1 and 2 months prior to uptake of the Vitality Active Rewards with Apple Watch benefit, months 0 to 5 after uptake and 6 months and forward. N=189,943.

Figure 4.3 reports the time trend for the positive association between the uptake of the Vitality Active Rewards with Apple Watch benefit and levels of physical activity for the SA sample. The time trends are very similar to the US sample, with an immediate increase in the total number of tracked activity days per month after uptake of the benefit. However, the increase in light activity days is modest and fades somewhat over time, although does not become statistically insignificant as for the US sample. Interestingly, looking at the number of tracked advanced activity days, we observe an increasing trend over time, suggesting that individuals may start with lighter or standard activity days and increase intensity over time.

In summary, looking at the time trends of the positive associations between the Active Rewards with Apple Watch benefit and increased physical activity, we observe that in general the positive associations sustains over time, especially for advanced activity levels. Hence the findings suggest that overall, the benefit is not only associated with increased activity levels, but also with increased intensity, with the findings suggesting that individuals may start with exercise events of light to standard intensity and individuals subsequently increase intensity of the activity over time.

Figure 4.3: Time passage of the association between the Vitality Active Rewards with Apple Watch benefit and physical activity, South Africa



Notes: figures report coefficients of estimating equation (2) with fixed-effects Poisson regression and clustered standard errors (insurance policy level); significance levels reported at the p<0.001 level. Reported are the effects for 1 and 2 months prior to uptake of the Vitality Active Rewards with Apple Watch benefit, months 0 to 5 after uptake and 6 months and forward. N=166,573

5 Conclusion

This study examines whether a loss-framed incentive such as the Vitality Active Rewards with Apple Watch benefit is associated with enhanced levels of physical activity among Vitality members beyond the levels already induced by a gain-framed incentive called Vitality Active Rewards. In essence, the Vitality Active Rewards incentive is a weekly scheme that aims to incentivise Vitality members with rewards such as cinema tickets, gift cards or free beverages if they track sufficient physical activity within a week. In addition, the Vitality Active Rewards with Apple Watch is provided for eligible Vitality programme members that allow them to purchase an Apple Watch for a small initial fee upfront; whilst the subsequent repayment amounts over 24 months are linked to the individual's tracked physical activity levels. For instance, if an individual engages in sufficient physical activity, the Apple Watch will be heavily discounted over the 24 months period with a member's payments potentially reduced to zero. Hence, the Vitality Active Rewards with Apple Watch benefit represents a suitable setup to test whether a loss-framed incentive can lead to more physical activity, in addition or relative to a gain-framed incentive. The existing empirical evidence suggests that rewarding individuals for physical activity can improve fitness levels but that a loss-framed incentive can indeed trigger relative changes in activity beyond rewards only, but most studies are based on small-scale RCTs for specific population sub-groups, and most effects tend to be short-lived. This study contributes to this literature by using a quasi-experimental approach combined with a large population-based dataset consisting of 422,643 individuals.

Our findings suggest that, across the three country samples, the uptake of the Vitality Active Rewards with Apple Watch benefit is associated with an average increase of tracked numbers of activity days per month by about 34 percent, leading to an additional 4.8 days of activity per month. There is some variation across the three country samples, with the largest percentage increase in total activity days in South Africa (44.2 percent), followed by the United States (30.6 percent) and the United Kingdom (27.7 percent). With regard to changes in intensity of the exercise, the largest absolute increase in advanced activity days is reported in the UK sample, where the uptake of the Vitality Active Rewards with Apple Watch benefit is associated with an average increase of 1.6 days of tracked activity per month. When looking at the time trends of the associations we further find that they persist over the intervention period of 24 months (the repayment period of the Apple Watch). The positive associations especially persist for the advanced activity levels, leading us to conclude that the benefit is not only associated with an increase in activity levels overall, but also with higher intensity over time.

In the sub-group analysis, we find that on average the at-risk group – defined as individuals who are obese and have relatively low activity levels – tend to possess a lower uptake of the Apple Watch benefit than the overall sample, suggesting that it is more difficult to engage this group of the population in physical activity. However, once the intervention has been taken up, the results suggest that this group show a comparatively stronger overall increase in physical activity than individuals who are not categorised in the at-risk group.

Overall the findings presented in this study suggest that incentives can play an important role in tackling inactivity, but the type of incentive matters. For instance, based on existing literature, gain-framed incentives such as rewards are likely to improve activity levels, but the evidence on the persistence of the effects is ambiguous. However, contributing directly to the literature, this study shows that in addition to a gain-framed incentive, a loss-framed incentive in which individuals have to pay back money (or in the subject of this study, have to pay back instalments for receiving an Apple Watch) can potentially induce increased levels of activity, as well as a higher intensity of the activity. These findings suggest that an intervention like the loss-framed Vitality Active Rewards with Apple Watch benefit has the potential to improve physical activity. This finding contributes to the emergent literature around the design of more effective health promotion programmes. Our results also show that it is more difficult to engage at-risk populations to buy into such incentives, but when they do, the relative activity improvements are larger than for the healthier and already active population.

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Appendix A: Summary of the literature linking financial incentives and physical activity

In this appendix we summarise the existing empirical literature that examines the link between financial incentives and physical activity. The Chapter is organised by papers with primary research (e.g. using new data and applying statistical models) and secondary research papers (i.e. systematic reviews or meta-analyses).

A.1. Primary research papers

Paper title	Paper Author(s) & Year	Paper summary	Outcomes of interest (e.g. steps, gym visits, BMI, heart rate)	Sample size (n)
Loss-Framed Financial Incentives and Personalized Goal-Setting to Increase Physical Activity Among Ischemic Heart Disease Patients Using Wearable Devices: The ACTIVE REWARD Randomized Trial	Chokshi et al. (2018)	**RCT** to determine the impact of a wearable activity tracker with financial incentives, for patients with heart disease. Physical activity significantly increased over the 16-week intervention, and was maintained during the 8-week follow up.	• Number of steps	105

Paper title	Paper Author(s) & Year	Paper summary	Outcomes of interest (e.g. steps, gym visits, BMI, heart rate)	Sample size (n)
Effectiveness of activity trackers with and without incentives to increase physical activity (TRIPPA): a randomised controlled trial	Finkelstein et al. (2016)	Year-long activity tracker intervention. **RCT** with 4 arms: 1) no tracker; 2) activity tracker; 3) tracker + charity incentive; 4) tracker + financial incentive; n=800. Financial incentive provided greatest improvement in MVPA, but this was not sustained after the incentives were discounted. No improvement in any health outcomes (e.g. weight). Employees from 13 Singapore organisations.	• Moderate-to-vigorous physical activity (MVPA) • Weekly steps	800
Individual versus team-based financial incentives to increase physical activity: a randomized, controlled trial	Patel et al. (2016)	13 week step count intervention. **RCT** with 4 arms: 1) feedback no $, 2) feedback and $ based on individual, 3) feedback and $ based on team, and 4) feedback and $ based on individual and team performance. Financial incentives based on individual and team performance (4) most effective.	• Number of steps	304
Framing financial incentives to increase physical activity among overweight and obese adults: a randomized, controlled trial	Patel et al. (2016)	13-week step count intervention. **RCT** with 4 arms: 1) daily feedback; 2) financial gain incentive; 3) lottery incentive; 4) financial loss incentive; n=281. Financial incentives framed as a loss (4) most effective. Single employer in the US.	• Number of steps - Whether participants met the daily goal of 7,000 steps - Mean proportion of participants meeting target during follow up - Mean daily steps	281

Paper title	Paper Author(s) & Year	Paper summary	Outcomes of interest (e.g. steps, gym visits, BMI, heart rate)	Sample size (n)
Using financial incentives to increase physical activity, weight loss and well being: a randomized control trial	Tanham et al. (2014)	Effects of 6-week intention prompts and financial incentives on physical activity in inactive individuals. **RCT**: 1) financial incentive; 2) intention prompt; 3) control group; n = 98. Intervention 1) and 2) equally effective at significantly improving physical activity. Single location in UK.	• Weight • Self-reported physical activity - IPAQ • Psychological well-being - GHQ-12	80
An adaptive physical activity intervention for overweight adults: a randomized controlled trial	Adams et al. (2013)	Comparing a 6-month adaptive physical activity intervention (one that adjusts goals based on participant performance) to a static intervention. **RCT** with 2 arms: 1) static intervention to encourage more steps; 2) adaptive intervention to encourage more steps; n=20. Adaptive intervention significantly increased number of steps. Single location in the US.	• Number of steps per day	20
Individual-versus group-based financial incentives for weight loss: a randomized, controlled trial	Kullgren et al. (2013)	24-week intervention of monthly weigh in, with financial incentives for hitting goals. **RCT** with 3 arms: 1) weigh-ins; 2) weigh-in with individual financial incentive; 3) weigh-in with group financial incentive; n=105. Group based incentive was more effective than individual incentive and monthly weigh-ins alone. Single employer in the US.	• Weight loss • Changes in behavioural mediators of weight loss	105

Paper title	Paper Author(s) & Year	Paper summary	Outcomes of interest (e.g. steps, gym visits, BMI, heart rate)	Sample size (n)
Financial motivation undermines maintenance in an intensive diet and activity intervention	Moller et al. (2012)	Testing the theory that financial incentives can demotivating if deemed controlling. 3-week **'Make Better Choices'** trial where participants received financial incentives contingent on meeting behaviour goals in the 3 weeks, and providing data beyond that. Financial incentives were unrelated to healthy behaviour or weight change in the 3-week trial, and negatively related to weight loss maintenance after this period. Single location in the US.	• Healthy lifestyle change • Weight loss	204
Incentives to exercise	Charness & Gneezy (2009)	**Field experiments** over 5 weeks to consider the impact financial incentives have on gym attendance and health indicators. Improvements were observed in both gym attendance and health indicators. Students at a single university in the US.	• Number of gym attendances • Health indicators - Weight - Waist size - Pulse rate	368
A randomized study of financial incentives to increase physical activity among sedentary older adults	Finkelstein et al. (2008)	Testing impact of financial incentives for walking on physical activity of 50+ aged adults. 4-week **RCT** with 2 arms: 1) fixed payment; 2) lower fixed payment plus further payment conditional on exercise level; n=70. Treatment group undertook significantly more activity, at additional average cost of $17.50 per participant per week. Single location in the US.	• Physical activity - 10+ minutes of continuous walking or jogging	51

Paper title	Paper Author(s) & Year	Paper summary	Outcomes of interest (e.g. steps, gym visits, BMI, heart rate)	Sample size (n)
Academic incentives for students can increase participation in and effectiveness of a physical activity program	DeVahl et al. (2005)	**Field experiment** to consider the impact academic incentives would have on a 12-week exercise programme aimed at reducing body fat of students; n=210. The group with the greater academic incentives had better adherence and lost more body fat. Students at a single university in the US.	• Adherence to exercise programme • Body fat	210

A.2. Secondary research papers

Paper title	Paper Author(s) & Year	Paper summary	Outcomes of interest (e.g. steps, gym visits, BMI, heart rate)	Sample size (n)
A systematic review of financial incentives for physical activity: the effects on physical activity and related outcomes	Barte et al. (2017)	**Systematic review** of the impact financial incentives have on physical activity, considering RCTs only. Identified 12 studies, some unconditional some conditional. Unconditional incentives do not affect physical activity. Conditional incentives do have an impact, particularly when conditional on physical activity behaviour, rather than just attendance.	• Physical activity	N/A
Personal financial incentives for changing habitual health-related behaviors: A systematic review and meta-analysis	Mantzari et al. (2015)	**Systematic review and meta-analysis** to determine whether financial incentives impact physical activity, among other things. 34/39 articles included in meta-analysis, majority US based. Financial incentives increased behaviour change, although effects dissipate 3 months after incentive removal.	• Smoking • Eating • Alcohol consumption • Physical activity	10,585

Paper title	Paper Author(s) & Year	Paper summary	Outcomes of interest (e.g. steps, gym visits, BMI, heart rate)	Sample size (n)
Financial incentives for exercise adherence in adults: systematic review and meta-analysis	Mitchell et al. (2013)	**Systematic review and meta-analysis** to determine whether financial incentives impact physical activity. 11 studies included, with positive effect on exercise in 8 of them. Overall, financial incentives increase exercise in the short term – only 1 found sustained exercise after 1 year, and only 2 found greater exercise continue after withdrawal of incentive.	• Energy expenditure • Aerobic fitness • Exercise session attendance • Aerobic minutes	1,453
Financial incentives and weight control	Jeffery (2012)	**Literature review** of empirical studies considering the impact of financial incentives on weight control. The evidence supports the notion that financial incentives improve weight control. However, results vary widely due to incentive size, schedule and context.	• Weight loss	N/A
Goal setting as a health behavior change strategy in overweight and obese adults: a systematic literature review examining intervention components	Pearson (2012)	**Systematic review** to understand the impact goal setting has on overweight adults. 18 studies included, showing goal setting is common in this context and a promising tool in weight loss programmes. However, goal setting is often undertaken in line with other interventions (e.g. education sessions), so causality could not be assigned.	• Weight loss • Physical activity - Number of steps • BMI • Waist circumference	N/A
Cost-effectiveness of interventions to promote physical activity: a modelling study	Cobiac et al. (2009)	**Cost-effectiveness analysis** of six different physical activity interventions in Australia. Pedometers and mass-media community campaigns are the most cost-effective interventions and very likely to be cost-saving. GP referrals to exercise physiologists were deemed least cost-effective.	• Disability Adjusted Life Year (DALY)	N/A

Paper title	Paper Author(s) & Year	Paper summary	Outcomes of interest (e.g. steps, gym visits, BMI, heart rate)	Sample size (n)
Systematic review of the use of financial incentives in treatments for obesity and overweight	Paul-Ebhohimhen & Avenell (2008)	**Systematic review** of RCTs of treatments for obesity involving financial incentives. Results from meta-analysis showed no significant effect on weight loss or maintenance at 12 and 18 months. Sub-analysis showed certain incentives were more likely to work than others; incentive > 1.2% disposable income, reward behaviour change, group performance.	• Weight loss	N/A
Impact of targeted financial incentives on personal health behaviour	Sutherland et al. (2008)	**Literature review** of financial incentives used to encourage 1) healthy behaviours, 2) wellness activities and 3) preventative services use. Financial incentives, even small ones, can influence health related behaviour. However, there are limitations in these studies abilities to produce guidance.	• Healthy behaviours	N/A
Effectiveness of monetary incentives in modifying dietary behaviour: a review of randomized, controlled trials	Wall et al. (2006)	**Systematic review** of RCTs of treatments to modify dietary behaviour. 4 studies were identified and all demonstrated a positive effect on at least one of the 'outcomes of interest' (in next column). However; studies were small and short, did not examine effects based on socioeconomic status or ethnicity, and did not measure cost effectiveness.	• Weight loss • Food purchase • Food consumption	N/A

Paper title	Paper Author(s) & Year	Paper summary	Outcomes of interest (e.g. steps, gym visits, BMI, heart rate)	Sample size (n)
A structured review of the effect of economic incentives on consumers' preventive behaviour	Kane et al. (2004)	**Systematic review** of the effect of economic incentives (e.g. cash, lottery, gifts, etc.) on preventative behaviour, including exercise and weight loss. Definitions of the economic incentive remarkably absent. The results of such incentives on exercise and obesity varied, with significant improvements shown in some studies and no improvement in others.	• Exercise (2 studies) • Obesity and weight loss (7 studies)	N/A
Effectiveness of physical activity interventions for older adults: a review	Van Der Bij et al. (2002)	**Literature review** of the effectiveness of physical activity interventions for older adults. A minority of the interventions used financial incentives, but there was no clear evidence that such behavioural reinforcement strategies had any impact on initiation and maintenance of physical activity.	• Physical activity	N/A

Appendix B: Associations between participating in Active Rewards and tracked physical activity levels

Independent of participating in the Vitality Active Rewards and Vitality Active Rewards with Apple Watch benefits, Vitality programme members can earn an assortment of longer term rewards – ranging from discounts on healthy food purchases to discounted flights, amongst others – by engaging in validated healthy lifestyle activities, such as health check-ups, healthy food purchases and tracking their activity through various wearable devices. Tracking activity is one channel through which a healthy lifestyle can be documented within the Vitality programme, but the study authors believe that participating in the Vitality Active Rewards or Active Rewards with Apple Watch incentives provides a stronger individual incentive for tracking physical activity levels in a more systematic, and hence accurate, manner. Consequently, in the interests of robustness, the main scope of this study is to assess whether the combined impact of Vitality's Active Rewards with Apple Watch programme leads to higher rates of activity relative to those engaging in the Active Rewards programme alone.

Nevertheless, in order to get a sense of magnitude of the association between levels of tracked activity and participating in Vitality Active Rewards, compared to not participating in Active Rewards or Active Rewards with Apple Watch, we use data for the same individuals included in the data samples described in Section 3.1, but also take into account the activity data before they participated in Active Rewards or Active Rewards with Apple Watch. Data on activity levels by individuals before they participated in Vitality Active Rewards was only available for the UK and US samples, and hence this analysis is restricted to these two county samples. We apply the same methodology as described in section 3.2, equation (1), but in addition to the intervention variable $VARAW_{i,my}$ we apply an additional indicator variable taking the value 1 if the individual participates in Vitality Active Rewards, $VAR_{i,my}$. In this setting, the coefficient for $VAR_{i,my}$ represents the association between tracked activity levels of participating in Active Rewards only compared to participating in the Vitality programme only, whereas the coefficient for $VARAW_{i,my}$ represents the association between participating in Active Rewards with Apple Watch and tracked activity compared to participating in Active Rewards only. The combination of the coefficients for both would represent the association between tracked activity levels and taking up the Active Rewards with Apple Watch benefit compared to participating in the Vitality programme only, without any of the two incentives activated. Table B.1 reports the corresponding parameter estimates.

The findings suggest that participating in VAR only is, on average, associated with an increase in total tracked activity of between 30.7 percent (UK) and 37 percent (US), compared to if the individual did not participate in either Active Rewards or Active Rewards with Apple Watch benefit.

Table B.1: Parameter estimates for the Vitality Active Rewards only and Vitality Active Rewards with Apple Watch benefit associations and physical activity

	United Kingdom				United States			
	VAR only		VARAW		VAR only		VARAW	
Dependent variables:	**beta**	**se**	**beta**	**se**	**beta**	**se**	**beta**	**se**
Total activity days	0.268	***(0.014)***	0.244	***(0.010)***	0.315	***(0.026)***	0.267	***(0.024)***
Light activity days	0.733	***(0.047)***	0.167	***(0.006)***	0.157	***(0.023)***	0.175	***(0.033)***
Standard activity days	0.549	***(0.038)***	0.224	***(0.009)***	0.472	***(0.041)***	0.310	***(0.051)***
Advanced activity days	0.447	***(0.035)***	0.317	***(0.019)***	0.522	***(0.058)***	0.421	***(0.052)***
No of observations	3,732,426				307,930			

Notes: standard errors (se) clustered reported (insurance policy level). Statistically significant parameters have a boldface marked standard error (p<0.001). The beta parameter estimates are from an individual fixed-effects Poisson regression estimating equation (1). The dependent variables are the number of activity days per month in total and by level of intensity (light, standard, advanced). The reported effects show the average differences in physical activity for individuals who (1) participate in VAR only, or/and (2) are taking up the Vitality Active Rewards with Apple Watch benefit compared to if the individual only participated in the Vitality programme.

Combined, this would suggest that an individual taking up the Active Rewards with Apple Watch benefit would on average increase the level of tracked activity by between 67 percent[23] (UK) to 79 percent (US) in total, compared to being a Vitality programme member only. However, as mentioned earlier, caution needs to be applied when comparing these estimates to the reference group of only participating in the Vitality programme and not activating any of the two incentives. That is, we hypothesise that individuals will more likely comply and have a relatively stronger incentive to track their activity systematically and hence more accurately if they receive a benefit or reward for it. Hence, comparing the associations between the intervention of taking up the Vitality Active Rewards with Apple Watch benefit and increased levels of activity compared to participating in Active Rewards only (reference group) mitigates this issue to some extent, as individuals are already incentivised to track activity systematically.

23 Calculated as: $(e^{0.244+0.268} - 1) * 100$.