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TECHNICAL REPORT FOR BODE³ INTERVENTION PARAMETER SELECTION: MOBILE HEALTH FOR PHYSICAL ACTIVTY

Version 1.0

Burden of Disease Epidemiology, Equity and Cost-Effectiveness Programme (BODE³)

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Introduction

A key component of the HRC-funded BODE[3] Programme 2016-2021 was to estimate the health and cost impacts of physical activity (PA) interventions. This report outlines the intervention and parameter selection process for two physical activity interventions: a mass media campaign to promote the use of high quality physical activity smartphone apps, and GP prescription of high quality physical activity apps. The health and cost impacts of these interventions were modelled using the Physical Activity and Active Transport (PAAT) Model (1). Further details about the PAAT Model have been published elsewhere (1) and are not covered in this report.

Insufficient physical activity contributes to poor health (2). In Aotearoa/New Zealand (NZ), half of adults fail to meet physical activity guidelines (3), which state that adults should aim to accumulate at least 150 minutes of moderate to vigorous physical activity throughout the week (2). Given the associated risks and high prevalence of physical inactivity, interventions are needed to increase population level physical activity in NZ.

There are a wide range of intervention options that could increase physical activity levels. Policy actions and interventions recommended by the World Health Organization include implementing communication campaigns, community-based programmes, improving walking and cycling infrastructure, increasing access to green space and sports amenities, and counselling on increasing physical activity by appropriately trained health providers (4). Within BODE[3], we have already examined the likely health impacts of increasing walking and cycling (5). For our additional work, we narrowed our focus to examine mobile health interventions targeting adult physical activity, which could be implemented in the NZ context.

Mobile health (mhealth) is defined by the NZ Ministry of Health as “mobile communication technologies, including the delivery of health information, health services, and healthy lifestyle support programmes” (6). Mhealth interventions are growing in popularity in part due to the perception of large scale adoption and low cost, but evidence regarding their long-term effectiveness and cost-effectiveness is limited (7). However evaluations of the effectiveness of physical activity smartphone apps in particular suggest that these are effective at increasing physical activity levels (8-10). With this in mind, we reviewed the literature to conceptualise two ways in which smartphone apps for physical activity could be promoted in the NZ context. Firstly, through a mass media campaign encouraging use of high quality physical activity smartphone apps. Secondly, through the ‘prescription’ of high quality smartphone apps for physical activity in primary care. We conducted rapid literature reviews to examine the available evidence for the above interventions, and to identify suitable modelling parameters. These parameters included effect sizes, uptake, adherence, and cost. The remainder of this report outlines the methods and results of the rapid reviews.

Methods

Search strategy

We searched Medline, PubMed and Scopus between April and August 2019. A variation of the following search strategy was modified according to the specifics of each parameter, ("activity tracker" OR "activity trackers" OR "fitness tracker" OR "fitness trackers" OR "step count" OR "step-count" OR mhealth OR m-health OR smartphone) AND physical* AND Review [Publication Type] AND PUBYEAR > 2017. The searches initially focused on systematic reviews from 2018 and 2019, using different publication types, and a broader time period, if no results were found.

Reviews and studies were considered if findings were likely to be easily scalable, assessed physical activity objectively (i.e. rather than via self-report), and predominately studied a healthy adult population. Also, high importance was placed on being able to generalise findings to the modern context. After the searches were performed, the titles and abstracts were assessed, and systematic reviews and journal articles were read in full to inform parameter selection.

Principles of parameter selection

Conceptualisation of the intervention and parameter selection was an iterative process whereby the intervention pathway was refined as evidence was identified. Where possible, parameter values were sourced from systematic reviews and meta-analysis or high-quality randomised controlled trials. We prioritised high quality studies where evaluated interventions were considered to have a high degree of overlap with the intervention as conceptualised, and where evidence was relevant to the NZ context. Where there were multiple options for specific parameter values, the strengths and limitations of different options were discussed by the research team to choose the best option for modelling. These different options were also used to inform estimates of the uncertainty around the chosen parameter. Due to the fast pace of mhealth technology development, some reviews were not included because, despite meeting other inclusion criteria, they were considered to be too out-of-date to be generalisable to the modern context (eg, (11-13)).

Where possible, uncertainty intervals (UIs) were based on uncertainty, or the plausible range, reported within the literature. Where no evidence was available, we used a generic approach used previously in BODE[3] work (14). This was based on the approximate degree of uncertainty: +/- 5% UIs for parameters with low uncertainty, +/- 10% for moderately uncertain parameters and +/- 20% for highly uncertain parameters.

Example of decision-making: physical activity increase in response to mass media campaign

Four systematic reviews met the inclusion criteria to be considered as the source of effect size estimates for the mass media campaign intervention. Out of these reviews, parameter values were taken from Gal, May, van Overmeeren, Simons, & Monninkhof (2018). Table 1 contains a brief description of each review and the justification for parameter selection.

Table 1: Examples of Justification for Parameter Selection or not

Source	**Justification**
Feter, dos Santos, Caputo, & da Silva, 2019 (9)	We did not use the values from this systematic review because: • The review included a broad range of studies, including randomised controlled trials (RCTs) and other study designs such as a quasi-experimental study. • Some studies were too diverse to generalise to our intervention. • There was high underlying variation due to heterogeneity rather than chance (I^2 = 88%), potentially indicating large variation between pooled studies.
Gal, May, van Overmeeren, Simons, & Monninkhof, 2018(8)	We used values from this review for the mass media campaign parameter. The review was chosen because: • The meta-analysis included RCTs only, • There was a good range of studies that were similar enough to our intervention. Most studies covered a healthy adult population, and although some studies included wearables, all but one of them included an 'app component'. • There was low heterogeneity when only studies assessed with a low risk of bias were pooled.
Brickwood, Watson, O'Brien,	This review was not used. The review evaluated commercial wearable devices instead of

& Williams, 2019 (15)	apps and we considered an app based approach more feasible in the NZ context than mass uptake of wearable devices.
Romeo et al 2019 (16)	We did not use values from this review for parameters because: • A small number of studies were included in the review and results were highly influenced by one study. • Some of the results were inconsistent with other systematic reviews listed. • Some of the studies were too diverse to generalise. • There was high heterogeneity (I^2=72%) reported.

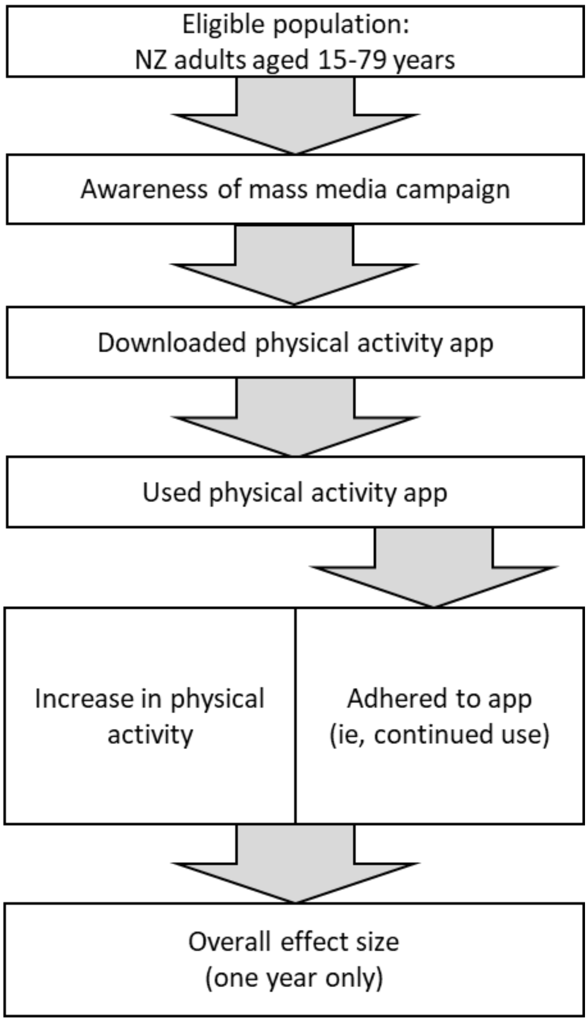
Intervention 1: Mass-media Campaign to Promote Physical Activity Apps

Intervention

We chose to model a mass-media health campaign that promotes PA apps for several reasons. Mass-media campaigns have already been used to promote PA in New Zealand (eg, (17)). Any new campaign could feasibly have an mhealth component as mhealth has recently been promoted by a number of government websites (18-21) and within government policy (22-25). Also, a number of mhealth apps with a physical activity component have been developed for New Zealanders (eg, (26-30)). Finally, mhealth interventions have potential to improve public health because they are inexpensive, easily accessible and can reach a large audience (31). For example, in 2017, there were 3.8 million mobile phones with internet access in New Zealand (32). In the same period, almost 320,000 health and wellness apps were available (33), many of them physical activity apps.

After deciding to model an mhealth mass-media campaign, we reviewed the literature to conceptualise the content of the campaign. Essentially such a mass-media campaign would promote the good quality physical activity apps available within New Zealand's Health Navigator App Library (34). Many physical activity apps are of poor quality (35); to mitigate this, the apps within the library have been reviewed by experts. Robust scoring instruments and guides to assess quality are also available (34). Other components of the campaign would be based on those run by New Zealand's Health Promotion Agency (36, 37), and the NHS run campaign to promote the Active 10 PA App (19).

Figure 1: Flow Chart of Mass-Media Intervention Conceptualisation



MVPA: Moderate-to-Vigorous Physical Activity
MET: Metabolic Equivalent of Task

As shown in Figure 1, after the campaign has been run, a proportion of New Zealand adults will be aware of the campaign's message. Some of these people will download an app, and some will use this app after seven days. Finally, a proportion will continue to use the app over the following year (adherence). We have taken a weighted average of adherence estimates at one month, three months and one year.

Parameters

Detail about the intervention content and parameters can be found in Table 2.

Table 2: Parameters used to Model a Mass-Media Campaign to Promote Physical Activity Apps

Parameter	**Key source**	**Supporting evidence / notes**	**Value (uncertainty intervals), distribution**
Percentage of the NZ population aware of mass media campaign	Cleghorn et al (2019) (36)	We assumed that 78% of New Zealand (NZ) adults will have some awareness of the mass media campaign to promote PA apps. To get this estimate, we used the values within in Cleghorn et al (2019), essentially using the average awareness from a number of health promotion campaigns run in NZ (37, 38).	78% (70% - 89%) Beta distribution
Percentage who downloaded a physical activity app	Krebs & Duncan, (2015) (39)	We estimated that 31% of people with awareness of the campaign would download a PA app onto their smartphone. This parameter is based off a survey on health app use in the United States (39). Within survey results, 31% of respondents reported using an app to track physical activity. This value was derived using the number of people who used health apps based to track activity (493) divided by the number of people who completed the survey (1604). See Appendix 2, item 5 from Krebs et al (2015) for more detail.	31% (21% - 41%) Beta distribution
Percentage who used the physical activity app	Brannan et al (2019) (19)	Using the best quality evidence we could identify, we assumed that around 16% of people are likely to use the app 7 days after download. We found both limited and conflicting evidence about app use within the literature. In one study, 66% of survey respondents that downloaded health apps, reported using them 1 or more times a day over a period of a month (39). Nevertheless, we suspect that survey respondents are over-reporting app use, and that the rate is likely to be lower. So our preferred estimate was 16%, based on the proportion of people likely to 'take action' after a mass-media campaign to promote app use in the UK (19). Evidence from the grey literature supports this assertion. An analysis of 300 million user profiles found that less than 10% of users return to apps 7 days after download (40). Another company found that only approximately 36% of iOS users will return to an app more than 11 times (41).	16% (10% - 36%) Beta distribution
Percentage of users who adhered to physical activity app (weighted annual average)	Guertler, Vandelanotte, Kirwan, & Duncan (2015) (42)	Based on a weighted average of adherence estimates, 15% of people will continue to use the physical activity app over a year. We used a number of estimates to create the average. Within Guertler et al 2015 adherence was at 30% (20% - 40%) at one month and 13% (3% - 23%) at three months (see 'App only' in figure 1). Also in figure 1, adherence stabilises at 13% at 90 days after first use. Similar results were also reported from a study of a Fitbit watch and app (43), so we assumed that adherence up to one year will stay around 12.5% (0% - 16%).	15% (10% - 21%) Beta distribution

Parameter	Key source	Supporting evidence / notes	Value (uncertainty intervals), distribution
Intervention increase in physical activity for those who adhered to the app	Gal, May, van Overmeeren, Simons, & Monninkhof (2018) (8)	On average, mhealth physical activity interventions result in an increase in physical activity, at least in the short term (3-5). As a result of the intervention, we assume physical activity would increase by 285 MVPA MET-minutes per week. (MVPA stands for moderate to vigorous physical activity, and MET-minutes stands for metabolic equivalent of task). Results from a systematic review with a meta-analysis of RCTs on PA apps were used to derive this estimate. The meta-analysis reported an average increase in 1404 steps per day, once results were weighted and the difference between the intervention and control were accounted for (8). We converted steps per day to MVPA MET-minutes per week using the method outlined within the PAAT Model Technical Report (44). The 'Steps to MVPA Conversion' section of this report also has further detail about the formula used.	285 MVPA MET mins/week (200-370) Normal distribution
Cost of a one-off national level mass media campaign	Cleghorn et al (2019)(36)	We used the values reported by Cleghorn et al (2019) (36) to estimate the cost of a mass media campaign. The majority of the overall cost was based on a 2013-14 campaign encouraging smokers to quit(45) . Although additional costs for staff management, promotion on government-funded websites, and additional administrative tasks, were also included in the estimate. See table 3 in Cleghorn et al (2019) for further detail. Costs were consumer price-index adjusted to the 2011 baseline year. The baseline year of the PAAT model was 2011, and cost parameters were converted to the 2011 NZ$ to reflect this. With the exception of costs, other parameters in this table are more current so they produce more relevant outputs.	$2,883,000 (SD +/- 20%) NZ$ 2011 Gamma distribution

Intervention 2: GP Prescribed Physical Activity App

The parameters for this intervention are being updated and will be published in due course. Please check here for an updated version.

Steps to Moderate to Vigorous Physical Activity (MVPA) Conversion

The conversion formula was MVPA MET min= ((((0.00071*steps per day)/4.4)*60)*3). MVPA MET min represents the metabolic equivalent of task minutes in moderate to vigorous physical activity.

Each part of this formula has been detailed within the table below.

Table 3: Steps to MVPA Conversion Description, Summary and Example

	Description	**Summary**	**Example**
1	We calculated distance travelled in kilometres (kms) per average step. We took an estimate of the average stride length (71 cm) (46), converted it to km (0.00071), and then multiplied by the total number of steps.	Stride length in km * total steps = km travelled.	0.00071 * 2000 steps = 1.42 km
2	We converted distance (in km) travelled to hours of physical activity. The average speed that New Zealander's walk (4.4 km per hour) was taken from the New Zealand Transport Survey report (47). Distance (in km) travelled was then divided by this average speed per hour.	Km / 4.4 km per hour = hours of physical activity.	1.42 km / 4.4 km/hr = 0.323 hours.
3	We converted hours to minutes.	Hours * 60 = minutes	0.323 * 60 = 19.38 mins
4	We converted minutes of physical activity to MET minutes in MVPA One minute of walking represents about 3 MET minutes in MVPA(48).	Minutes of PA * 3 METs = MET minutes in MVPA.	19.38 * 3 = 58.14 MET mins in MVPA.

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