Mind the gap: Habit and self-determined motivation predict health behaviours in middle-aged and older adults

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Objectives. Physical activity and fruit and vegetable consumption are two key health behaviours associated with the health and well-being of middle-aged and older adults. The present research investigated how habit and self-determined motivation interact with intention to prospectively predict physical activity and fruit and vegetable consumption in middle-aged and older adults.

Design. A prospective correlational design (two data collection points) was used.

Methods. A convenience sample of 195 adults completed online questionnaires measuring intention, habit, and self-determined motivation. One week later, 177 participants (67.2% female), aged 52–87 years ($M = 61.50$, $SD = 5.90$), completed self-report measures of physical activity and fruit and vegetable consumption over the previous week.

Results. Separate hierarchical multiple regression analyses were conducted. For physical activity, the model explained 46% of the variance in behaviour, $F(8, 168) = 17.88$, $p < .001$ and a large effect size ($f^2 = .85$). Two-way interactions contributed an additional 3.70% of unique variance in physical activity, $F(3, 165) = 4.07$, $p = .008$, $f^2 = .04$. For fruit and vegetable consumption, the model explained 19.20% of the variance in behaviour, $F(5, 171) = 8.13$, $p < .001$ and a medium effect size ($f^2 = .24$). Two-way interactions did not significantly improve the model, $F(3, 168) = 1.68$, $p = .174$.

Conclusions. Habit and self-determined motivation were both important in narrowing the intention–behaviour gap for two key health behaviours, and combining these processes may better inform strategies to support people's intentions to improve these health behaviours.

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Statement of contribution

What is already known on this subject?

- Physical activity and fruit and vegetable are suboptimal in middle-aged and older adults.
- Psychosocial predictors of these behaviours vary across populations.
- Both self-determined motivation and habit have been found to be important across different studies.

What does this study add?

- Habit and self-determined motivation were both important in narrowing the intention–behaviour gap for physical activity and fruit and vegetable consumption.
- These predictors differed across the two behaviours.
- Combining these processes may better inform strategies to support change in these health behaviours.

Background

Due to a rapidly ageing population, the need to address the associated risk of disease and means of improving the health and well-being of middle-aged and older adults is becoming a major focus of psychological research (Prince et al., 2015). Physical activity and fruit and vegetable consumption are two key health behaviours that protect against the onset of chronic health conditions (Lee et al., 2012; Wang et al., 2014). It is recommended in global physical activity guidelines that older adults engage in at least 150 min of moderate physical activity or 75 min of vigorous physical activity per week (Physical Activity Guidelines Advisory Committee, 2008). However, engagement in physical activity decreases with age (Kao, Jarosz, Goldin, Patel, & Smuck, 2014), with only 7% of adults aged over 60 years engaging in recommended levels of physical activity in the United States (Sun, Norman, & While, 2013). For fruit and vegetable consumption, guidelines suggest that daily consumption of at least two cups of fruit and three cups of vegetables is beneficial to health (WHO, 2003). Fruit and vegetable consumption is associated with several health benefits for older adults (Nicklett & Kadell, 2013) and may protect against the development and exacerbation of chronic diseases (Hung et al., 2004), support cognitive functioning (Johnson et al., 2008; Polidori et al., 2009), and support better physical functioning in older adults (Alipanah et al., 2009; Drewnowski, & Evans, 2001; Semba, Lauretani, & Ferrucci, 2007). Compared to younger age groups, older adults tend to consume more fruit and vegetables and less high-energy–low-nutrient foods (Nicklett & Kadell, 2013); however, only a small proportion, approximately 8%, of American adults consume the recommended quantity per day (Rehm, Penalvo, Afshin, & Mozaffarian, 2016).

The need to increase physical activity and fruit and vegetable consumption in middle-aged and older age groups has led to an increase in research investigating the efficacy of interventions targeted at population groups transitioning through major life events, such as retirement (Baxter et al., 2016; Lara et al., 2014). This transition period, occurring up to 10 years pre- and post-retirement, offers a potential window of opportunity for behaviour change (McDonald et al., 2017). Epidemiological factors, such as socio-economic status and self-reported health status, can significantly influence physical activity maintenance and fruit and vegetable consumption in adults (Amireault, Godin, & Vézina-Im, 2013; Riediger & Moghadasian, 2008). Although such factors are beneficial for identifying population groups in need of intervention, they are often impossible to change. Therefore, a better understanding of the malleable psychological factors that predict behaviour in a population transitioning to retirement will help inform, and improve the success of, interventions.

Theoretical intention–behaviour gap

Psychological theories such as temporal self-regulation theory (Hall & Fong, 2007) and the theory of planned behaviour (Ajzen, 1991) assert that intention is a primary predictor of behaviour. Indeed, empirical research has supported this proposition with regard to physical activity (Mullan, Henderson, Allom, & Orbell, 2016) and fruit and vegetable consumption (Guillaumie, Godin, & Vézina-Im, 2010). However, a meta-analysis by McEachan, Conner, Taylor, and Lawton (2011) found that in adult samples, intention only accounted for 21% of variance in physical activity and 27% of the variance in eating. The variance unaccounted for suggests the presence of an intention–behaviour gap. It has been proposed that behaviour may be better explained by including other post-intentional factors, both implicit and reflective, that have the potential to increase the likelihood of an individual taking action (Murray & Mullan, 2019).

Temporal self-regulation theory suggests that intention, behaviour prepotency, and self-regulation influence behaviour (Hall & Fong, 2007). Behaviour prepotency is the extent to which past behaviour and habit strength predicts behaviour at the post-intentional stage and is represented as the implicit or *automatic* and habitual tendency of behaviour execution (Hall & Fong, 2007). Self-regulation, as outlined by self-determination theory (Ryan & Deci, 2017), suggests that sustained engagement in a behaviour is largely dependent on autonomous motivation such as engaging in a behaviour because of personal interest or perceived value. Individuals who engage in autonomously regulated behaviours are more likely to maintain self-initiated behaviours as they reflectively or *consciously* place a high value on the outcomes associated with the behaviour (Deci & Ryan, 2000). Indeed, a recent meta-analysis has shown that interventions designed to increase self-determined motivation result in positive changes in health behaviours (Ntoumanis et al., 2020). We propose that self-determined motivation moderates the association between intention and behaviours. Sheeran and Webb (2016) proposed that intentions differ not only in terms of strength or valence, but also in terms of other qualities (e.g., stability, quality of behavioural motivation); self-determination theory suggests participants' autonomous reasons for acting is a key component of intention calibre and therefore qualifies as a potential moderator of intention–behaviour consistency. Empirical evidence has supported this suggestion in the physical activity (Chatzisarantis, Biddle, & Meek, 1997) and eating (Pelletier, Dion, Slovinec-d'angelo, & Reid, 2004) domains. Researchers have demonstrated that the two separate cognitive processes (automatic and conscious) operate in parallel when an individual intends to engage in a behaviour (Caudwell, Keech, Hamilton, Mullan, & Hagger, 2019).

Behaviour prepotency and habits

Habitual behaviour is defined as patterns of behaviour that are regularly performed over time within a similar context and eventually require little conscious decision-making (Gardner, de Bruijn, & Lally, 2011). Habits have been studied in various health behaviours including binge drinking (Black, Mullan, & Sharpe, 2017; Murray & Mullan, 2019), food consumption (Evans, Norman, & Webb, 2017; Moran & Mullan, 2021), and supplement use (Allom, Mullan, Clifford, Scott, & Rebar, 2018). Some research has found habit to be a significant predictor of engagement in physical activity (Gardner et al., 2011) and fruit and vegetable consumption (Allom & Mullan, 2012; Evans et al., 2017). There is some variation in the literature regarding how behaviour prepotency is operationalized. For example, some studies have investigated behaviour prepotency as a combined construct (past behaviour and habit strength; Booker & Mullan, 2013) or by investigating past behaviour

and habit strength separately (Evans et al., 2017; Murray & Mullan, 2019) or by using habit alone (Mullan et al., 2016). In this paper, we measure past behaviour and habit, as this is the most frequent operationalization.

Further, the relationship between habit and intention is complex but it has been argued that there is a moderating effect such that modest experience strengthens the intention–behaviour consistency, whereas considerable experience weakens intention–behaviour consistency (Sheeran, Godin, Conner, & Germain, 2017).

Self-determined motivation

Self-determination theory is a macro-theory of human motivation which proposes three broad domains of motivation that regulate an individual's health behaviours (Ryan & Deci, 2017). When individuals engage in *autonomously* regulated behaviours, it could be due to internal rewards such as pleasure (intrinsic motivation), the fact that the behaviour is aligned with personal goals or values (integrated regulation), or because the individual values the outcomes of the behaviour (identified regulation). However, individuals can also be motivated to engage in behaviours for *controlled* reasons, such as doing it out of guilt (introjected regulation) or because others pressure them to engage in the behaviour (external regulation). Finally, people may be *amotivated* which infers a lack intention to perform the behaviour.

These motivation regulations are commonly used to assess motivation to engage in physical activity (Kirkland, Karlin, Stellino, & Pulos, 2011; Wilson, Sabiston, Mack, & Blanchard, 2012) and daily fruit and vegetable consumption (Pelletier et al., 2004; Sweeney & Freitas, 2018). Evidence from systematic reviews (Teixeira, Carraça, Markland, Silva, & Ryan, 2012) and meta-analyses (Ng et al., 2012; Ntoumanis et al., 2020) provide support for the positive effects of high self-determined motivations (intrinsic, integrated, and identified) on engagement in physical activity and fruit and vegetable consumption. Interestingly, a meta-analysis of studies that integrated the theory of planned behaviour and self-determination theory did not find any direct effects of self-determination on intentions or behaviour (Hagger & Chatzisarantis, 2008). Despite this, more recent evidence supports the role of habit in physical activity and dietary behaviours and the existence of the intention–behaviour gap merits further exploration of any interaction effects.

The current study

The overall aim of the current study is to address the intention–behaviour gap by investigating whether behaviour prepotency and self-determined motivation can predict physical activity and fruit and vegetable consumption in middle-aged and older adults. Specifically, the aim of the study is to investigate how behaviour prepotency and self-determined motivation interact with intention to prospectively predict these health behaviours. It is hypothesized that behaviour prepotency will moderate the relationship between intention and behaviour (physical activity and fruit and vegetable consumption) such that intention is a better predictor at high levels of behaviour prepotency (H1). Secondly, it is hypothesized that self-determined motivation will moderate the relationship between intention and behaviour (physical activity and fruit and vegetable consumption) such that intention is a stronger predictor at high levels of self-determined motivation (H2).

Method

Participants

The required sample size was calculated using Tab achnick and Fidell's (2013) formula for multiple regressions; $N > 50 + 8(k)$. For a medium-sized effect and 14 predictors (including potential covariates) for both physical activity and fruit and vegetable consumption, a minimum sample of 162 participants was required. To account for attrition, a total of 195 participants were recruited at time one (T1). One week later (T2), 177 (90.77%) participants completed the second questionnaire. The final sample consisted of 177 participants aged 52–87 years ($M_{age} = 61.50$, $SD_{age} = 5.90$; 67.20% females). Among these, 29.90% were fully retired ($M_{age} = 59.32$, $SD_{age} = 6.29$) and 70.10% either semi-retired or not retired.

Measures

Demographics

Participants reported age, gender, retirement status, retirement age, and subjective socio-economic status. Participants were required to select from a list of common health conditions in older populations (Prince et al., 2015). The Activities of Daily Living Questionnaire (EQ-5D-5L; Buchholz, Janssen, Kohlmann, & Feng, 2018) was used to measure perceived quality of life in relation to mobility, self-care, usual activities, pain/discomfort, and anxiety/depression, as well as a rating of participant health 'today'.

Intention

Two items measured intention in relation to physical activity and fruit and vegetable consumption (e.g., 'I intend to be physically active/eat fruit and vegetables in the next week'; Ajzen, 2002). Participants responded on a 7-point Likert scale from 1 (*strongly disagree*) to 7 (*strongly agree*) with higher scores indicating stronger intention. In this sample, the two items demonstrated good internal consistency for physical activity ($\alpha = .94$) and fruit and vegetable consumption ($\alpha = .89$).

Behaviour prepotency

Past behaviour was measured using the IPAQ-SF and the 2-Item Cup fruit and vegetable screener at T1. Habit strength was measured using the 12-item Self-Report Habit Index (SRHI; Verplanken & Orbell, 2003). Participants indicated the degree to which physical activity/fruit and vegetable consumption is habitual (e.g., 'physical activity / eating fruit and vegetables is something that belongs to my weekly routine'), on a 7-point Likert scale ranging from 1 (*strongly disagree*) to 7 (*strongly agree*). High scores indicated greater habit strength. In this sample, the SRHI demonstrated excellent internal consistency for physical activity ($\alpha = .97$) and fruit and vegetable consumption ($\alpha = .96$).

Self-determined motivation

The Behavioural Regulation in Exercise Questionnaire version 3 (BREQ-3) was slightly adapted by changing the specified behaviour in each question to measure six types of motivation regulations (Markland & Tobin, 2004; Wilson et al., 2012). The BREQ-3 is originally a measure of exercise behaviour; however, for the purpose of consistency

throughout the questionnaire, the BREQ-3 was also adopted to measure behaviour regulations associated with fruit and vegetable consumption. In previous studies, the BREQ-3 demonstrated excellent internal consistency of $\alpha > .90$ (Pelletier et al., 2004; Sweeney & Freitas, 2018) and demonstrated good internal consistency for physical activity ($\alpha = .90$) and fruit and vegetable consumption ($\alpha = .86$) in this study.

On a 5-point Likert scale indicating 0 (*not true for me*), 2 (*sometimes true for me*), and 4 (*very true for me*), the BREQ-3 measures amotivation (e.g., 'I don't see the point in being physically active/eating fruit and vegetables'), external (e.g., 'I engage in physical activity/ eat fruit and vegetables because other people say I should'), introjected (e.g., 'I feel guilty when I don't engage in physical activity / eat fruit and vegetables'), identified (e.g., 'I value the benefits of physical activity / eating fruit and vegetables'), integrated regulation (e.g., 'I consider being physically active / eating fruit and vegetables as part of my identity'), and intrinsic motivation (e.g., 'I enjoy my physical activity sessions/eating fruit and vegetables'). For the purpose of parsimony, self-determined motivation was calculated by an unweighted relative autonomy index (RAI; Sheldon, Osin, Gordeeva, Suchkov, & Sychev, 2017), with higher scores indicating greater self-determined motivation.

Physical activity

Engagement in physical activity over the previous week was measured using the International Physical Activity Questionnaire-Short Form (IPAQ-SF; The IPAC Group, 2018). The IPAQ-SF measures the days per week and hours per day of vigorous (e.g., aerobics) and moderate (e.g., doubles tennis) intensity activity, walking (e.g., for recreation), and sitting. The IPAQ-SF was scored using Cheng's (2016) spreadsheet, transforming scores into metabolic equivalent task minutes per week (MET-minutes). Total physical activity was calculated by summing the MET-minutes for vigorous, moderate, and walking activities. Evidence for acceptable criterion validity, test–retest reliability (Silsbury, Goldsmith, & Rushton, 2015), and good concurrent validity (Shenoy, Chawla, & Sandhu, 2014) has been reported.

Fruit and vegetable consumption

To assess average daily consumption of fruit and vegetable consumption over the previous week, the 2-Item Cup F/V screener (Yaroch et al., 2012) was used. Participants indicated their average daily consumption in cups on a scale from 1 (*½ cup or less*) to 6 (*4 or more cups*), with reference to a table containing one-cup equivalents of common fruits and vegetables. Mean responses were calculated in cups (e.g., 1 to 2 cups = 1.50 cups) and summed to indicate total fruit and vegetable consumption per day. The 2-Item Cup F/V screener has shown acceptable levels of validity and reliability as a short-item measure (Yaroch et al., 2012).

Research design and procedure

This study employed a prospective correlational design in which data were collected at two time points, one week apart. Ethics approval was obtained from the University's Human Research Ethics Committee. The Qualtrics questionnaire was shared on Amazon Mechanical Turk (MTurk) to 'workers' aged 50 years and over, as well as 'workers' who were located in the United States, had completed at least 100 questionnaires, and had approval rates of 97–100%. Participants were provided with information regarding

participation, the background of the study, and information regarding confidentiality and data storage, at both T1 and T2. Informed consent was obtained by participants selecting 'Agree' before proceeding.

The first questionnaire took approximately 20 min, and participants were compensated 50 cents USD by entering a 'secret' completion code into MTurk. This ensured that only participants who fully completed the questionnaire were compensated (Mason & Suri, 2012). One week later, participants received an email via their MTurk ID, with the link to the second questionnaire measuring their physical activity and fruit and vegetable consumption over the previous week. This questionnaire took approximately 5 min, and participants were compensated $1 USD by entering a different completion code. Responses were matched via MTurk ID's and all identifiable information was removed.

Data analysis

Correlation coefficients (Table 2) were computed to examine relationships between variables and to identify which control variables to retain in the main analyses. Health factors, including socio-demographic variables that were significantly correlated with physical activity and/or fruit and vegetable consumption, were added as covariates in the main analyses. Separate hierarchical multiple regression analyses were conducted for physical activity and fruit and vegetable consumption, and self-determined motivation and behaviour prepotency and their interactions with intentions were also examined in separate analyses. The covariates shown to be significantly related to the outcomes in the correlation analysis were entered in Step 1. Intention was entered in Step 2, followed by behaviour prepotency or self-determined motivation in Step 3. Standardized 2-way interactions were entered in Step 4. To test for moderation and the nature of significant interactions, predictor variables were standardized, and simple slope analyses were conducted as recommended by Dawson (2014).

Results

Missing value analysis revealed that data were missing completely at random for physical activity measures, $\chi^2(10,352) = 2,916.21, p = 1.000$, and no missing data were identified for fruit and vegetable consumption. Prior to conducting the main analyses, assumptions were tested and met. Detected outliers were recoded to the nearest non-outlier (Tabachnick & Fidell, 2013). Descriptive statistics and correlations between health behaviours and predictor variables are presented in Table 1. Significant correlations identified age, health conditions, quality of life, health rating, and SSS as covariates for physical activity, and gender and retirement status as covariates for fruit and vegetable consumption (Table 2). These variables were therefore entered as covariates in the main analyses as relevant.

We decided to remove past behaviour from the regression due to its strong correlation with physical activity, $r(175) = .80, p < .01$, suggesting possible multicollinearity (Tabachnick & Fidell, 2013). Behaviour prepotency was therefore determined by habit strength from the SRHI and will be referred to as habit for the rest of the manuscript. For the purpose of consistency of predictors across behaviours, past behaviour was also removed for fruit and vegetable consumption.

Table 1. Summary of intercorrelations, means, standard deviations, and range for scores on predictors and health Behaviours

Variable	1	2	3	4	5	M	SD	Range
1. Behaviour	—	.52*	.64*	.80*	.41*	2,629.03	2,381.53	0 to 7,950
2. Intention	.27*	—	.78*	.50*	.65*	5.08	1.77	1 to 7
3. Habit strength	.39*	.58*	—	.61*	.68*	4.00	1.68	1 to 7
4. Past behaviour	.63*	.41*	.49*	—	.41*	2,472.11	2,353.35	0–8,052
5. Self-determined Motivation	.30*	.61*	.69*	.37*	—	4.07	3.57	−4.25 to 12
M	3.80	6.25	5.17	4.13	5.58			
SD	2.21	.79	1.35	2.35	3.26			
Range	.50 to 9	4.50 to 7	2.15 to 7	.50 to 9	−.25 to 12			

Notes. Intercorrelations presented above the diagonal are for PA and below the diagonal for FVC. Means, standard deviations, and range in vertical columns are for PA, and in horizontal rows for FVC.

*p < .01.

Table 2. Summary of intercorrelations of control variables and health behaviours

Variable	Physical activity	Fruit and vegetable consumption
1. Age	−.20**	-.05
2. Gender	−.14	.17*
3. Retirement status	.12	.19*
4. Health conditions	−.23**	−.14
5. Quality of life	.20**	.10
6. Health rating	.30**	.04
7. SSS	.16*	.08

Notes. SSS = subjective socio-economic status.
*$p < .05$; **$p < .01$.

Physical activity

Participants reported engaging in an average of 2,629.03 MET-minutes of physical activity per week at T2 ($SD = 2,381.53$, range = 0–7950 MET-minutes). In step 1 of both analyses predicting physical activity, control variables accounted for a significant 14.20% of the variance in physical activity, $F(5, 171) = 5.64, p < .001$. At Step 2, as displayed in Table 3, intention accounted for an additional 20% of the variance, $\Delta F(1, 170) = 51.59, p < .001$. In step 3, habit accounted for an additional 11.80% of the variance in physical activity, $\Delta F(1, 169) = 36.80, p < .001$. The interaction between intention and habit accounted for a further 2.80% of the variance in physical activity behaviour, $\Delta F(1, 168) = 9.07, p = .003$). Overall, the model accounted for 48.70% of the variance, which is equivalent of an effect size of $f^2 = .95$, which is considered 'large' by Cohen's (1988) conventions. As seen in Figure 1, positive relationships between intention and physical activity were observed for those with weak habits, $b = 659.34, t = 3.10, p = .002$, yet stronger positive associations were evident for participants with strong habits, $b = 1,676.08, t = 4.33, p < .001$.

In the second model, self-determined motivation (step 3) did not add unique variance to physical activity above and beyond intention $\Delta F(1, 169) = 1.96, p = .16$. The 2-way interaction between intention and self-determined motivation (step 4) also did not add unique variance to the model, $\Delta F(1, 168) = 1.22, p = .27$.

Fruit and vegetable consumption

Participants reported an average of 3.80 cups of fruit and vegetables a day ($SD = 2.21$, range = .50–9 cups). At Step 1, control variables accounted for a significant 6.40% of the variance in fruit and vegetable consumption, $\Delta F(2, 174) = 6.00, p = .003$. At Step 2, as displayed in Table 3, intention accounted for an additional 6.30% of the variance, $\Delta F(1, 173) = 12.48, p < .001$. At Step 3, habit accounted for a further 6.50% of the variance, $\Delta F(1, 172) = 13.75, p < .001$. The interaction between intention and habit was added in Step 4 but did not add significantly to the model, $\Delta F(1, 171) = .62, p = .43$. In total, the model accounted for 19.50% of the variance in fruit and vegetable consumption, which is equivalent to an effect of $f^2 = .24$, which is considered 'medium' (Cohen, 1988). In the second analysis where self-determined motivation was replaced with habit, results showed that self-determined motivation failed to add significantly to the prediction of fruit and vegetable consumption, over and above intention, $\Delta F(1, 172) = 3.60; p = .06$. However, the interaction between intention and self-determined motivation (Step 4) explained a significant 2.30% of the variance in the model, $\Delta F(1, 171) = 4.81, p = .03$.

Table 3. Unstandardized (B) and Standardized (β) Regression Coefficients, Standard Error ($SE\ B$), and squared semi-partial correlations (sr^2) for predictor variables on each step of a hierarchical multiple regression predicting PA and FVC ($N = 177$)

Predictor		Physical activity				Fruit and vegetable consumption			
		B [95% CI]	SE B	β	sr^2	B [95% CI]	SE B	β	sr^2
Step 1	Control variables[a]	5,818.52 [942.45, 10,694.58]*	2,470.23			.95 [−.72, 2.61]	.84		
Step 2	Intention	1,167.71 [846.77, 1,488.64]**	162.58	.49	.20	.56 [.25, .87]**	.16	.25	.06
Step 3	Habit	1,343.62 [906.37, 1780.87]**	221.49	.56	.12	.70 [.33, 1.07]**	.19	.32	.06
Step 4	Intention X Habit	543.76 [204.46, 883.06]**	171.86	.23	.03	.11 [−.17, .39]	.14	.06	.003
Step 1	Control variables[a]	5,818.52 [942.45, 10694.58]*	2,470.23			.95 [−.72, 2.61]	.84		
Step 2	Intention	1,167.71 [846.77, 1488.64]**	162.58	.49	.20	.56 [.25, .87]**	.16	.25	.06
Step 3	Self-determined motivation	284.00 [−116.77, 684.77]	203.01	.12	.01	.38 [−.02, .78]	.20	.17	.02
Step 4	Intention X self-determined motivation	188.38 [−148.51, 525.27]	170.65	.08	.01	.34 [.03, .65]*	.16	.18	.02

Notes. CI = confidence interval.

[a]Control variables included age, health conditions, quality of life, health rating, and subjective socio-economic status for PA, and gender and retirement status for FVC.; *$p < .05$; **$p < .01$.
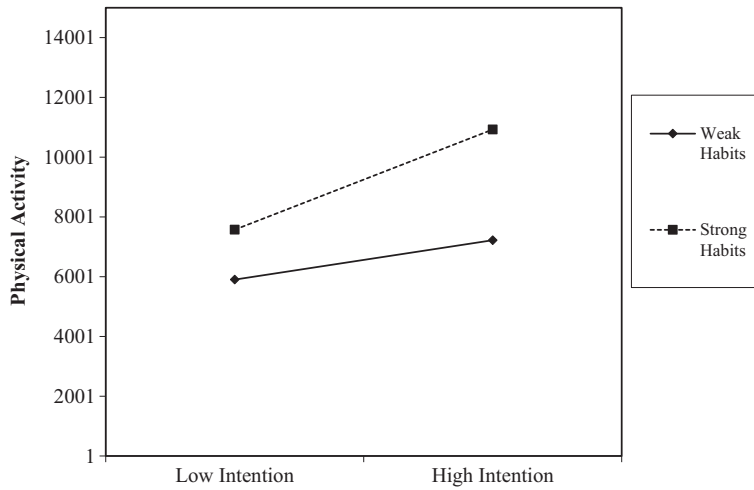
Figure 1. The relationship between intention and PA is moderated at strong habits.
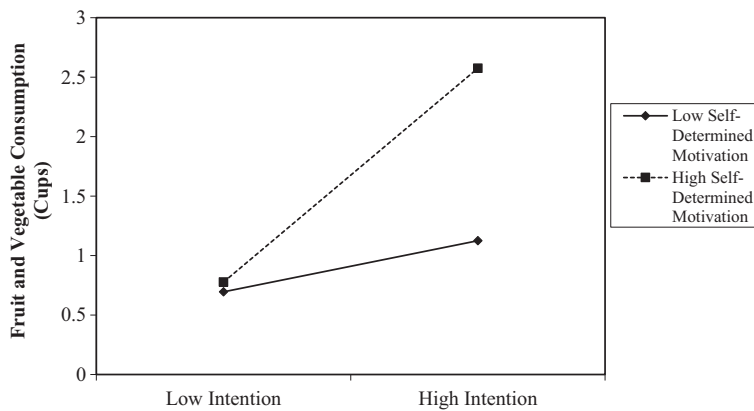
Figure 2. The relationship between intention and FVC is moderated at high levels of self-determined motivation.

The model explained a total of 16.90% of the variance in fruit and vegetable consumption which is equivalent to a medium-sized effect ($f^2 = .20$). As seen in Figure 2, there was no relationship between intention and fruit and vegetable consumption observed for those with low self-determined motivation, $b = -.13$, $t = -.60$, $p = .55$, but a positive relationship was evident for those with high self-determined motivation, $b = .73$, $t = 2.49$, $p = .01$.

Discussion

A better understanding of the psychological processes that predict physical activity and fruit and vegetable consumption in middle-aged and older adults is an important step towards effectively improving the health of the population. The aim of this study was to investigate whether automatic and conscious processes, including habit and self-determined motivation, can predict physical activity and fruit and vegetable consumption

behaviour beyond intention. Consistent with previous literature (Allom & Mullan, 2012; Collins & Mullan, 2011; Kothe, Mullan, & Butow, 2012; Kothe & Mullan, 2015; McEachan et al., 2011), intention positively predicted both behaviours, yet a large amount of variance remained unaccounted for, suggesting an intention–behaviour gap.

The hypothesis that habit will moderate the relationship between intention and behaviour was supported for physical activity. High intention to engage in physical activity was a stronger predictor when habits were strong. This is in contrast to some findings that suggest that in moderated regression and structural equation modelling analyses, the relationship between intention to engage in physical activity and behaviour is stronger when people do not have a habit of being physically active than when they do (van Bree et al., 2013; de Bruijn & Rhodes, 2011). The explanation for these contradictory findings may be that, rather than being a linear relationship, the relationship between physical activity and habit is quadratic as supported by evidence from Sheeran et al. (2017).

Future research needs to explore if this might explain some of the inconsistent findings. In contrast, this moderating effect was not found when predicting fruit and vegetable consumption. This unexpected finding is inconsistent with previous research indicating the predictive utility of strong habits for fruit and vegetable consumption in younger samples (e.g., Evans et al., 2017). Nevertheless, present findings align with other research demonstrating that different health behaviours can have different determinants (Collins & Mullan, 2011; Evans et al., 2017). For example, Evans et al. (2017) found that habit did not predict fruit and vegetable consumption, however it did predict unhealthy snacking behaviour. Additionally, fruit and vegetable intake may require a higher degree of planning and food preparation skill (Larson, Perry, Story, & Neumark-Sztainer, 2006) than opportunities for impulsive snack food consumption. In addition, the inconsistency between predictors of fruit and vegetable consumption in middle-aged and older adults and younger adults warrants further investigation as there may be alternative explanations for this surprising finding, such as changes to routines, autonomy, and other environmental factors.

The hypothesis that self-determined motivation will moderate the relationship between intention and behaviour was supported for fruit and vegetable consumption only. It is important to note that self-determined motivation did not add unique variance to either physical activity or fruit and vegetable consumption, and thus, results should be interpreted with caution. Simple slope analysis revealed that intention for fruit and vegetable consumption was a stronger predictor when motivation was more self-determined, supporting evidence that perceived psychological value and alignment with personal goals is important to foster to increased fruit and vegetable consumption in this population (Ntoumanis et al., 2020; Teixeira et al., 2012).

However, the moderating effect of self-determined motivation was not identified for physical activity, which contrasts with literature emphasizing that physical activity is more likely to be maintained when the behaviour is highly valued by the individual (Kirkland et al., 2011). It is possible that this study could not capture this level of self-determined motivation for physical activity maintenance as engagement was measured over a short period of seven days. Further, measures used to assess self-determined motivation (such as the BREQ-3 used in the present study) are designed to assess motivation for planned, structured exercise, not incidental physical activity. This could be an issue given that the measure employed to assess physical activity in the present study (the IPAQ-SF) captures all types of physical activity and exercise. As such, potential effects could have been diluted.

Strengths and limitations

One of the strengths of the current study was that it is the first to examine interactions between self-determination motivation and habit in the prediction of two key health behaviours in middle-aged and older adults. Nevertheless, a limitation of the present research was the use of self-report questionnaires and a brief follow-up period to measure engagement in physical activity and fruit and vegetable consumption. Although the IPAQ-SF is a well-validated measure, research has shown that self-reported physical activity is often overestimated (Lee, Macfarlane, Lam, & Stewart, 2011). Future research could incorporate the use of device-based measures (e.g., Fitbit, accelerometers) and more detailed self-report assessments to match self-report engagement, as well as more comprehensive measures to gain a better understanding of predictors of different forms of PA (e.g., running) and other elements of healthy diets (e.g., low fat intake) assessing context, mode, and patterns of engagements in these behaviours. Additionally, a longer period between time points could allow for a more accurate picture of an individual's typical physical activity or dietary behaviour.

In line with the limitations of self-report questionnaires for physical activity, future research could incorporate the use of device-based measures (i.e., accelerometers) and more detailed self-report assessments assessing context, mode, and patterns of engagements in these behaviours. Another area for future research may be around habit. In the current study, this construct was determined by habit strength as assessed by the SRHI (Verplanken & Orbell, 2003). Given the development and determinants of habit may be influenced by environmental cues (Booker & Mullan, 2013), investigation of potential cues to action to identify which environmental triggers (physical, sensory, social, internal, and emotional) are important for eliciting physical activity and fruit and vegetable consumption behaviours may be valuable. This approach has been successfully applied in recent research investigating the predictors of binge drinking behaviour in university students (Murray & Mullan, 2019).

Additionally, other factors have been found to moderate the intention–behaviour relationship such as planning (Hamilton, Kothe, Mullan, & Spinks, 2017) and self-efficacy (Sainsbury et al., 2018), and this could be explored in future research.

Finally, we need to acknowledge that the factors that predicted the two behaviours differed, and while this is consistent with other literature into other behaviours (e.g., Charlesworth, Mullan, & Moran, 2021; Liddelow et al., In Press), it requires replication. Future research testing the constructs across different populations and behaviours is needed to allow replication of the findings to help elucidate the behaviours and populations where these constructs have particular predictive utility.

Theoretical and practical implications

Through the use of a prospective correlational design, this study adds to the limited knowledge on the predictors of physical activity and fruit and vegetable consumption in middle-aged and older adults. Studies investigating similar periods have either focussed on its impact on health (McDonald et al., 2017), or have sampled from more readily accessible population groups, such as university students (Allom, Mullan, Cowie, & Hamilton, 2016). In order to extend these findings to the potential window of opportunity provided by the retirement transition period, future research could utilize a longitudinal design in which these predictors are measured within 10 years before retirement and up to 10 years after retirement. This could capture changes in behaviour, and predictors of behaviour, across the retirement transition period.

Theoretically, this study provides partial evidence for the application of habit and self-determined motivation as supportive mechanisms for physical activity and fruit and vegetable consumption behaviours. The results suggest that habit strength may be important for middle-aged and older adults intending to increase physical activity, whereas self-determined motivation may be more important for middle-aged and older adults intending to increase fruit and vegetable consumption. These results suggest that the predictors of physical activity and fruit and vegetables are different, and this has important implications for understanding of these behaviours in middle-aged and older adults. They are also supported by a lot of research in other populations and other behaviours where the importance of automatic and conscious predictors of behaviours varies (Gardner et al., 2020; Liddelow et al., 2020; Novoradovskaya et al., 2020) and as such lends support for the integration of different theories when predicting health behaviours, such as temporal self-regulation and self-determination theory in this study.

This study also provides important practical implications for interventions aiming to increase engagement in physical activity and promote fruit and vegetable consumption in middle-aged and older adults. To support these groups intending to engage in physical activity, interventions should incorporate specific strategies for developing strong habits. Bélanger-Gravel, Godin, and Amireault (2013) refer to 'If-then' plans as a common strategy for habit development by emphasizing cues when intending to engage in physical activity. For example, tying physical activity plans to specific places, times of day or certain people will help develop a routine, consequently leading to non-conscious associations between the cue and physical activity intentions. Additionally, to support fruit and vegetable consumption intentions in this group, interventions should incorporate strategies to help people feel more self-determined by enhancing their basic psychological needs. Self-determined motivation can be fostered via need-supportive communication strategies used by significant others in their social environment (Hancox, Quested, Ntoumanis, & Thøgersen-Ntoumani, 2018), as these will help satisfy the psychological needs for autonomy (feelings of control), competence (feelings of mastery), and relatedness (feelings of belongingness) which are required to experience self-determined motivation (Ryan & Deci, 2017). Thus, it may be fruitful to design interventions that involve significant others who are trained to use need-supportive communication styles when the ultimate goal is to increase fruit and vegetable consumption in middle-aged and older adults.

Conclusion

The current study provides support for the role of automatic and conscious processes in narrowing the intention–behaviour gap for two key health behaviours. Overall, findings suggest that different predictors may be important for different behaviours. The development of strong habits is likely to support those with high physical activity intentions to promote behavioural engagement, whereas enhancing self-determined motivation may support fruit and vegetable consumption intention in middle-aged and older adults. It is important in future research to investigate how behaviour, and predictors of behaviour, changes during the retirement transition and whether the combination of both automatic and conscious theories can better inform strategies to effectively support people's intentions to improve these health behaviours.

Conflicts of interest

All authors declare no conflict of interest.

Author contributions

Barbara Ann Mullan, Ph.D. (Conceptualization; Formal analysis; Investigation; Methodology; Project administration; Supervision; Writing – original draft; Writing – review & editing) Claudia Olivier (Conceptualization; Formal analysis; Investigation; Writing – original draft) Cecilie Thogersen-Ntoumani (Conceptualization; Formal analysis; Investigation; Methodology; Project administration; Supervision; Writing – original draft; Writing – review & editing).

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