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Dual processing approach to sedentary behavior and physical activity in the workplace

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Abstract

Regular physical activity is an important health promoting behavior. Yet, many adults live sedentary lifestyles, especially during their workday. The current study applies an extended theory of planned behavior model, incorporating affective attitudes and instrumental attitudes, along with habit, to predict limiting sedentary behavior and physical activity within an office environment. Theory of planned behavior constructs and habit were assessed with an online survey on a sample of 180 full-time office workers, with self-reported behavior assessed 1 week later (M*age* = 25.97, SD*age* = 10.24; 44 males, 134 females, and 2 nonbinary). Model fit was indicated by BRMSEA ($M = 0.057$, $SD = 0.023$), $B\ \gamma\hat{}$ ($M = 0.984$, $SD = 0.010$) and BCFI ($M = 0.959$, $SD = 0.026$), accounting for 46.1% of variance in intention, 21.6% of variance in sedentary behavior, and 17.4% of variance in physical activity behavior. A Bayesian structural equation model revealed direct effects of instrumental attitudes and perceived behavioral control on intention to limit sedentary behavior, direct effects of intention and perceived behavioral control on limiting sedentary behavior, and direct effects of perceived

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behavioral control and habit on engaging in physical activity. The current study indicates intentions to be active in the office are primarily driven by beliefs about the benefits of activity and individuals' perceived level of control, rather than normative or affective beliefs. As behavior was predicted by both intention and habit, findings also indicate office-based activity is likely not always a consciously driven decision. These findings may have implications for improving activity levels in this highly sedentary population.

KEYWORDS
affective attitudes, habits, instrumental attitudes, physical activity, sedentary behavior, TPB

INTRODUCTION

Regular physical activity has been identified as one of the most important health promoting behaviors, demonstrating diverse and wide-reaching health-enhancing benefits (Rhodes et al., 2017; Warburton & Bredin, 2017). Despite this, 25% of adults globally and 45% of Australian adults do not meet the recommended physical activity guidelines (Australian Bureau of Statistics, 2018; World Health Organization, 2020). Also of concern is that 44% of Australian adults describe their day at work as mostly sedentary (Australian Bureau of Statistics, 2018). Sedentary behavior rates are increasing, coinciding with advancements in technology and decreases in physically demanding jobs (Borodulin et al., 2008; Brownson et al., 2005; Kirk & Rhodes, 2011; Matthews et al., 2008; Straker & Mathiassen, 2009). As sedentary behavior has been linked to a number of health issues, ranging from metabolic dysfunction and reduction in bone mineral density to heart disease and diabetes (Hamburg et al., 2007; Noble et al., 2015; World Health Organization, 1998, 2015; Zwart et al., 2007), it is important to examine effective ways to increase physical activity and reduce sedentary behavior. This is particularly relevant for highly sedentary populations such as those holding office jobs (Parry & Straker, 2013), that is, people who work in an office preforming tasks such as clerical or administrative work. As lack of time is one of the most commonly reported barriers to performing physical activity (Dugdill et al., 2008; Rhodes & De Bruijn, 2010; Salmon et al., 2003), one potential avenue to help reduce sedentary behavior and promote increases in physical activity could be to increase the amount of movement performed over the course of a workday. Therefore, the aim of the current study was to apply an extended theory of planned behavior (TPB) on reducing sedentary behavior and engaging in physical movement within the office.

Along with the chronic health conditions associated with sedentary behavior, office workers are at particularly high risk of developing health issues such as altered curvature of the spine, skin discoloration and varicose veins from poor circulation, and vision issues associated with computer usage (Emanuele, 2008; Hemingway et al., 1997; Higham, 2019; Hitosugi et al., 2000; Loh & Redd, 2008). Increasing the amount of movement performed over the course of the day can help prevent this demographic from developing long-term health issues that can impede their longevity (Emanuele, 2008; Hitosugi et al., 2000; Mokdad et al., 2016; Noble et al., 2015; Nylander, 2016; World Health Organization, 2015). Reviews on workplace interventions, aimed at increasing physical

activity in the workplace, have found confounding results (Malik et al., 2014). For example, Malik et al. (2014) found that only 32 of the 58 studies reviewed showed an increase in physical activity, with inconclusive evidence to suggest which types of interventions were more effective. Similarly, systematic reviews on workplace interventions aiming to reduce sedentary behavior have found mixed results (Brierley et al., 2019; Commissaris et al., 2016; Martin et al., 2015). In their review, Brierley et al. (2019) found that 21 of 30 interventions showed reduced sedentary behavior with no apparent consistencies with which behavior change techniques showed an effect.

When trying to understand the active mechanisms in interventions, previous research has applied behavior change theories to physical activity research with the aim of understanding the psychological determinants underlying behavioral action. Such theories include social cognitive theory, self-determination theory, the transtheoretical model of change, and the TPB (Hagger & Chatzisarantis, 2009; Nigg et al., 2011; Roberts et al., 2010; Symons Downs & Hausenblas, 2005). Among these theories, the TPB has been most widely applied to behaviors such as physical activity (Rhodes et al., 2019). The TPB highlights intention as the most proximal predictor of behavior, which in turn is predicted by constructs such as: *attitudes*, which represent evaluations about the behavior; *subjective norms*, which relate to the perceived supports and pressures from significant others towards the behavior; and *perceived behavioral control*, which relates to belief in one's capabilities and access to necessary resources to perform the behavior (Ajzen, 1991). Although there has been extensive support for the TPB in the prediction of physical activity, there still appears to be a substantial portion of variance unaccounted for (McEachan et al., 2011; Rhodes & de Bruijn, 2013). Similarly, when looking at the TPB's predictability of sedentary behavior, Prapavessis et al. (2015) found that the model variables accounted for between 8% and 43% of variance in behavior. Similarly, Rhodes and Dean (2009) used a TPB framework to look at four leisure time sedentary behaviors: watching television, computer usage, reading or listening to music, and socializing within both a university and community sample. Their results indicated that the TPB predicted between 6% and 63% of variance in behavior, with an average of 30.25%. Although these findings suggest that the TPB framework is useful at understanding both physical activity and sedentary behavior, it also appears that other psychological processes could be at play.

Recent expansions of the TPB have explored the role of attitude, specifically, looking at the differences in effect between instrumental attitudes and affective attitudes (Phipps et al., 2021; Rhodes et al., 2022). Affective attitudes refer to the emotional perceptions towards a behavior (i.e. dull or enjoyable), as opposed to the traditional instrumental attitudes, which relate to the perceived benefits of the behavior (i.e. worthless or valuable; Crites et al., 1994). Affective attitudes are divergent from affect proper (the emotional experience within the moment) in that they are judgments about future emotional experience, which is said to influence future behavior nonconsciously (Stevens et al., 2020). When applied to physical activity, affective attitudes relate to the emotional experiences that arise when people think about future exercise. Studies predicting physical activity have found affective attitude to have moderate-to-strong influence on intention (French et al., 2005; Lowe et al., 2002; Magnan et al., 2013; Rhodes et al., 2009). However, when applied to sedentary behavior, the relationship is less clear. Prospective research looking at the effects of both affective and instrumental attitudes on sedentary behavior have found both to be influential with varying effects (Lowe et al., 2015; Rhodes & Dean, 2009). Although, within intervention research, it appears that affective attitudes have more of an influence over reducing sedentary behavior as opposed to instrumental attitudes (Lithopoulos et al., 2020). To date, the vast majority of the research looking at the effects of affective attitudes have been applied to moderate-to-vigorous physical activity (Lowe et al., 2002; Phipps et al., 2021; Rhodes et al., 2009), with few studies looking at sedentary behavior and light physical activity during working hours.

Along with affective attitudes, to increase the amount of variance explained in predicting behavior, research has sought to include nonconscious processes within models of social cognition (Hamilton et al., 2018; Hannan et al., 2019; Phipps et al., 2020, 2022; Triandis, 1977). Dual process models stipulate that behavior has both a reflective pathway, whereby behavior is a conscious choice, as well as a nonconscious pathway, whereby behavior is a result of automatic responses learnt through associative memory and cued by environmental stimuli (Gardner, 2015; Hagger, 2019; Hofmann et al., 2008; Rhodes, 2017, 2021; Strack & Deutsch, 2004; Triandis, 1977). A key construct in dual process models is habit, defined in contemporary research as automatically activated cue-behavior scripts triggered by encountering behavior-relevant stimuli (Gardner, 2012; Hagger, 2019). Previous literature has assessed the effects of habits on physical activity and sedentary behavior and found promising results for habit to be a prominent predictor (Conroy et al., 2013; Gardner et al., 2011; Rebar et al., 2016). Physical activity and sedentary behavior are often discussed as opposing behaviors; however, the two are not necessarily predicted by the same social psychological constructs (Spence et al., 2017). Evidence suggests that sedentary behavior does not displace physical activity (Biddle et al., 2004; Pearson et al., 2014). For example, one can be sufficiently active whilst also engage in high levels of physical activity (Ekelund et al., 2016). However, it is important to note that some form of movement (i.e. light physical activity) is likely to replace sedentary behavior (Janssen et al., 2020); therefore, exploring this transfer is important to further our understanding of these behaviors. Also, there is dominant focus on understanding the determinants of physical activity in the current literature (Spence et al., 2017), with limited research focused on sedentary behavior and simply moving more. To advance knowledge and provide formative evidence to inform future work practices, it is important to understand the influential constructs that underpin limiting sedentary behavior in the workplace. Furthermore, to date, there is a dearth of research exploring the role of nonconscious processes, such as habits, on sedentary behavior, and even less literature looking at the relationships between affective and instrumental attitudes, as well as habits on sedentary behavior during working hours.

The current study aims to understand the associations of an extended TPB that includes habit, as well as the instrumental and affective components of an attitude, on the behaviors of reducing sedentary behavior and increasing physical activity within the workplace environment. In line with Phipps et al. (2020), it is hypothesized that instrumental attitude (H1a), affective attitude (H1b), subjective norm (H1c), and perceived behavioral control (H1d) will directly and positively predict intention to limit sedentary behavior; intention (H2a) and perceived behavioral control (H2b) will directly and positively predict the behavior of limiting sedentary behavior; similarly, intention (H3a) and perceived behavioral control (H3b) will directly and positively predict engaging in physical activity. Further, in line with the traditional TPB model (Ajzen, 1991), social cognition variables (affective attitudes, instrumental attitudes, subjective norms, and perceived behavioral control) are also predicted to indirectly positively predict each behavior via intention; lastly, that habit to engage in sedentary behavior will have a direct and negative effect on limiting sedentary behavior (H4a), as well as engaging in physical activity (H4b).

METHOD

Design and procedure

The study adopted a two-wave prospective survey design, where participants were asked to complete two online self-report questionnaires 1 week apart. The Time 1 questionnaire involved

obtaining informed consent followed by questions pertaining to the constructs within the proposed model and demographic questions. The Time 2 questionnaire involved questions relating to behavior and habit for both sedentary behavior and physical activity. Upon registering their interest in the study, participants were presented with the study information sheet, and consent to participate was obtained via completion of the questionnaire. Full ethical approval was granted by the Griffith University Human Ethics Committee (GU:401/2020).

Participants

Participants were full-time office workers, who were also undertaking between one to four units of undergraduate study, recruited via convenience sampling through the Griffith University's participation pool between February and July 2021. The Griffith University's participation pool recruits through first-year core subjects and offers students course credit to participate in research. With the use of a screening question, participants were included in the study if they self-described as having a sedentary job and work from either a commercial office, home office or a combination of both. Participants were excluded if they had received medical advice to restrict physical activity of light intensity. A total of 264 participants consented to participate and completed the Time 1 questionnaire. However, 47 participants selected no to the screening question of having a full-time job and 36 did not complete the Time 2 survey. The final sample included in analysis consisted of 180 full-time office workers, of which 87 worked from a commercial office, 30 worked from a home office, and 63 worked from a combination of commercial and home office ($M_{age} = 25.97$, $SD_{age} = 10.24$; 44 males, 134 females, and 2 nonbinary). While traditional power analysis does not strictly apply to Bayesian statistics, analysis using web power for an equivalent frequentist model indicated a minimum recommended sample of 176 for RMSEA-based model fit (power = .80, maximum RMSEA = .08). The adequacy of power in the final model is also confirmed in sensitivity, bias, and convergence tests presented in the Supporting Information.

Measures

The psychosocial constructs were measured using multi-item psychometric instruments developed using standardized guidelines (Ajzen, 2002). These items were adapted from previous research for use with the current target behavior and constructed in accordance with recommendations (Ajzen, 2002; Gardner et al., 2012; Hamilton et al., 2019; Phipps et al., 2020). Similar belief measures have demonstrated good correspondence with objective measures (Hamilton et al., 2012; Innerd et al., 2015). Zero-order correlations are provided in Table 1.

Demographic variables

Participants were asked to self-report their age (in years), gender (man, woman, nonbinary, prefer not to say), ethnicity (Australian, Australian Aboriginal or Torres Strait Islander or South Sea Islander, other), disruptions to workplace (no, yes), and workplace environment (working from commercial office, home office, or combination of commercial and home).

Physical activity

Physical activity behavior was defined as any bodily movement produced by skeletal muscles that results in energy expenditure and increases heart rate and breathing, such as lifting, carrying

TABLE 1 Zero-order correlations, reliability statistics, and descriptives.

	1	2	3	4	5	6	7	8	9	10
1. Age	-									
2. Gender	−.003	-								
3. Affective attitude	.128	−.056	-							
4. Instrumental attitude	.187*	.015	.649***	-						
5. Subjective norm	.201**	.142	.387***	.477***	-					
6. PBC	−.022	−.107	.221**	.227**	.179*	-				
7. Intention	−.038	.036	.240**	.382***	.243**	.655***	-			
8. Habit	.155*	.154*	−.095	.058	.201**	−.224*	−.229*	-		
9. Sedentary behavior	.090	.039	−.054	.060	.144	.043	.089	.271***	-	
10. Physical activity	−.390***	−.101	−.054	−.128	−.092	.266***	.219*	−.228*	−.049	-
Mean	25.97	-	4.87	5.48	4.90	4.18	4.26	4.76	4.12	3.33
Standard deviation	10.24	-	1.42	1.50	1.40	1.63	1.57	1.75	0.94	1.99
Reliability	-	-	0.94	0.93	0.85	0.92	0.95	0.98	0.84	0.90

Note: Reliability is calculated as Cronbach's α.

*$p < .05$.

**$p < .01$.

***$p < .001$.

light loads, climbing stairs, or walking (Ross et al., 2020). Physical activity behavior was measured using two items (e.g. "In the past week, I performed physical activity as part of my daily work routine"), where items were scored on a 7-point Likert scale (1 = *false* and 7 = *true*; Ajzen, 2002).

Sedentary behavior

Sedentary behavior was defined as any waking behavior characterized by low energy expenditure while in a sitting, reclining, or lying posture (Ross et al., 2020). Sedentary behavior was measured using two items (e.g. "Think about the past week. In general, how often did you limit your sedentary behavior as part of your daily work routine"), where items were scored on a 7-point Likert scale (1 = *never* and 7 = *always*; Ajzen, 2002).

Habit

Habit towards engaging in sedentary behavior was measured using the four items of the Self-Report Behavioral Automaticity Index (e.g. "Do you agree that engaging in sedentary behavior as part of your daily work routine is something ... I do without having to consciously remember"). All items were scored on a 7-point Likert scale (1 = *strongly disagree* and 7 = *strongly agree*; Gardner et al., 2012; Rebar et al., 2018).

Affective attitude

Affective attitude for sedentary behavior was measured using four items preceded by the common prompt "Limiting sedentary behavior as part of my daily work routine in the next week would be ...." All items were scored on a 7-point sematic differential scales (e.g. [1] *Dull* to [7] *Fun*; Ajzen, 2002).

Instrumental attitude

Instrumental attitude for sedentary behavior was measured using four items preceded by the common prompt "Limiting sedentary behavior as part of my daily work routine in the next week would be ...." All items were scored on a 7-point sematic differential scales (e.g. [1] *Worthless* to [7] *Valuable*; Ajzen, 2002).

Subjective norm

Subjective norm for sedentary behavior was measured using three items (e.g. "Most people who are important to me would approve of me limiting sedentary behavior as part of my daily work routine"). All items were scored on a 7-point Likert scale (1 = *strongly disagree* and 7 = *strongly agree*; Ajzen, 2002).

Perceived behavioral control

Perceived behavioral control for sedentary behavior was measured using four items (e.g. "It is mostly up to me whether I limit sedentary behavior as part of my daily work routine."). All items were scored on a 7-point Likert scale (1 = *strongly disagree* and 7 = *strongly agree*; Ajzen, 2002).

Intention

Intention to limit sedentary behavior was assessed by three items (e.g. "It is likely that I will limit sedentary behavior as part of my daily work routine"). All items were scored on a 7-point Likert scale (1 = *strongly disagree* and 7 = *strongly agree*; Ajzen, 2002).

Data analysis

An extended TPB model was tested using a Bayesian structural equation model, where attitude was divided into its affective and instrumental components and habit was included as an additional predictor of behavior. We also controlled for the effects of workplace location (i.e. commercial office, home office, or a combination of commercial and home) on limiting sedentary behavior and physical activity. Surveys utilized force responses ensure no missing data; case wise deletion was used for participants who did not complete Time 2 survey as these data were deemed not missing at random (Allison, 2001). The Bayesian approach accounts for previous findings when calculating the mean and variance estimates for the current data, as opposed to calculating them in isolation. This approach results in a higher accuracy of parameter estimates than what would

be gained from traditional frequentist methods. Where there is synergy between the current observations and prior findings, Bayesian analysis provides a more precise estimate of the model effects and their distributions, with narrow posterior highest density intervals akin to higher power. If there is inconsistency between the prior research and the current findings, the analysis results in highly variable distributions indicative of low precision, with wide posterior highest density intervals. Therefore, a Bayesian structural model identifying the hypothesized direct and indirect relations among model constructs was used for the current study and fitted using the blavaan package in R (Makowski, 2018; Merkle & Rosseel, 2015; R Core Team, 2013). Where available, identical pathways were sourced from Phipps et al. (2020). The model was run with three MCMC chains using the JAGS package (Depaoli et al., 2016; Plummer, 2012). Maximum likelihood analysis was used to derive starting values of MCMC chains. Successful convergence is indicated by all PSRF less than 1.05 (Gelman & Rubin, 1992). The WAMBS checklist procedures were also used to confirm successful convergence and to check the quality and replicability of the final model (Depaoli & Van de Schoot, 2017). The posterior mean deviance method with the leave-one-out information criterion was used to calculate the fit statistics (Garnier-Villarreal & Jorgensen, 2020).

Bayesian adaptations of the root mean square error of approximation (BRMSEA) gamma hat ($B\gamma\hat{}$) and comparative fit index (BCFI) were used to assess model fit with acceptable fit indicated by the statistics >.90 and lower than .08 respectively. Results are presented as the mean and standard deviation of statistics between iterations. The posterior predictive *p*-value (PPP) is also presented as a fit statistic for Bayesian modeling, with a PPP of .5 indicating optimum fit. However, the PPP should be interpreted with caution as it has been considered a sensitive indicator of fit within complex models (Cain & Zhang, 2019; Garnier-Villarreal & Jorgensen, 2020; Hoofs et al., 2018; Levy, 2011), akin to χ^2 in maximum likelihood statistics. Results are presented with 90% highest density intervals, as per recommendations for Bayesian analysis (Kruschke, 2014; Makowski et al., 2019; McElreath, 2020).

We tested hypotheses for individual parameter estimates using the probability of direction statistic adjusted for reporting equivalent to a traditional *p*-value (Makowski et al., 2019). The probability of direction statistic is based upon the proportion of iterations in which the parameter estimate was in the same direction as the reported mean parameter estimate in the final model (Makowski et al., 2019). The behavior of this statistic is strongly related to the traditional *p*-value in maximum likelihood and frequentist statistics (i.e. near one-to-one equivalent) and can thus be interpreted in the same manner as a traditional *p* statistic such that a value of less than .05 indicates the parameter estimate is significantly different from zero in a frequentist interpretation.

RESULTS

Preliminary analysis

Zero-order correlations, descriptives, and internal consistency statistics are provided in Table 1. Participants were screened and excluded from the analysis if they reported not having a full-time job. For those participants who were eligible for the study, no significant differences were found between those included in the final sample and participants who did not complete the Time 2 survey in terms of gender ($\chi^2(2) = 0.506$, $p = .776$), age ($t(214) = 1.060$, $p = .305$), ethnicity ($\chi^2(2) = 0.575$, $p = .750$), disruptions to workplace ($\chi^2(2) = 1.215$, $p = .270$), workplace environment ($\chi^2(2) = 0.930$, $p = .629$), or Time 1 model constructs (Wilk's lambda = 0.92, $F(6, 209) = 1.45$, $p = .198$).

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Bayesian structural equation model

Model fit

Successful convergence was attained after 100,000 post-burn-in iterations (all PSRF values >1.01). Regarding model fit, BRMSEA ($M = 0.057$, $SD = 0.023$), $B\ \gamma\hat{}$ ($M = 0.984$, $SD = 0.010$), McDonald index ($M = 0.961$, $SD = 0.024$), and BCFI ($M = 0.959$, $SD = 0.026$) indicated good fit of the model with the data (Jorgensen et al., 2019). In contrast, the PPP did not indicate good fit (PPP = 0.110).

Testing model hypotheses

Overall, the model predicted 46.1% of variance in intention to limit sedentary behavior, 21.6% of variance in limiting sedentary behavior, and 17.4% of variance in engaging in physical activity. Figure 1 displays the final model with standardized path estimates. Table 2 reports the posterior means, standard deviations, highest density intervals, and equivalent *p*-values. The results showed nonzero effects of instrumental attitude (supporting hypothesis H1a) and perceived behavioral control (supporting hypothesis H1d) on intention to limit sedentary behavior and nonzero effects of intention (supporting hypothesis H2a) and perceived behavioral control (supporting hypothesis H2b) on the behavior of limiting sedentary behavior. Furthermore, results showed nonzero effects of habit (supporting hypothesis H4b) and perceived behavioral control (supporting hypothesis H3b) on engaging in physical activity. Contrary to our hypothesis, effects of affective attitude (H1b) and subjective norm (H1c) on intention to limit sedentary behavior were not significantly different from zero. Similarly, the effects of habit (H4a) on limiting sedentary behavior and intention (H3a) to limit sedentary behavior on engaging in physical activity were not significantly different from zero. Results showed nonzero indirect effects of instrumental attitude and perceived behavioral control on limiting sedentary behavior through intention, suggesting a significant indirect effect. Contrary to hypothesis, the indirect effects of affective attitude and subjective norms on behavior were not significantly different from zero. While workplace location was included as a covariate, it did not significantly influence either behavior.

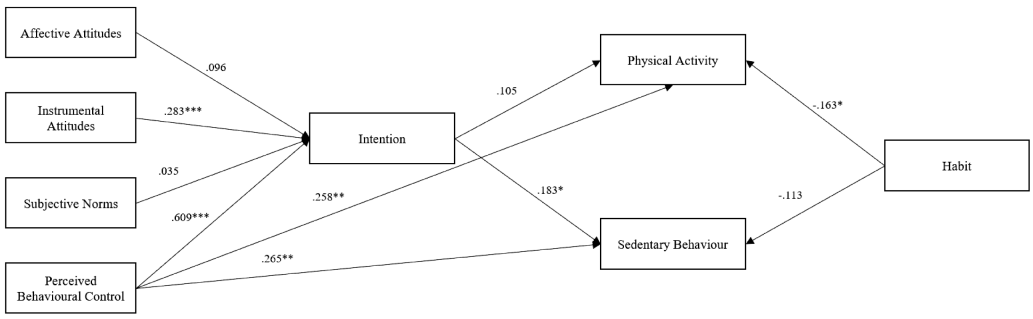

FIGURE 1 The proposed structural model including standardized beta of posterior means. The model predicting limiting sedentary behavior and engaging in physical activity. *Note*: $p = .05^{*}$, $p = .005^{**}$, $p < .001^{***}$.

TABLE 2 Unstandardized and standardized posterior parameter estimates with highest posterior density and hypotheses testing statistics.

Path	Prior	Post. Mean	Post. *SD*	.050 *HPD*	.950 *HPD*	*p eqv.*
Direct effects						
SB affective attitudes → SB intention	.322	−.100	.071	−.241	.040	.159
SB instrumental attitudes → SB intention	.083	.297	.074	.156	.446	<.001
SB subjective norms → SB intention	.107	.036	.062	−.084	.159	.561
SB PBC → SB intention	.434	.602	.056	.495	.713	<.001
SB intention → SB behavior	.303	.187	.089	.010	.357	.035
SB habit → SB behavior	-	−.114	.070	−.251	.025	.104
SB PBC → SB behavior	-	.268	.090	.087	.440	.003
Home group → SB behavior	-	.099	.149	−.193	.391	.505
Mixed group → SB behavior	-	−.269	.194	−.646	.114	.166
SB intention → PA behavior	.303	.107	.091	−.069	.285	.243
SB habit → PA behavior	-	−.163	.072	−.302	−.018	.024
SB PBC → PA behavior	-	.262	.092	.078	.438	.005
Home group → PA behavior	-	.053	.153	−.254	.345	.724
Mixed group → PA behavior	-	−.231	.200	−.622	.160	.246
Covariances						
SB affective attitudes ↔ SB instrumental attitudes	-	.475	.061	.364	.602	<.001
SB affective attitudes ↔ SB subjective norms	-	.213	.053	.109	.317	.000
SB affective attitudes ↔ SB PBC	-	.077	.051	−.026	.174	.128
SB affective attitudes ↔ SB habit	-	−.080	.053	−.188	.020	.118
SB instrumental attitudes ↔ SB subjective norms	-	.276	.047	.185	.373	<.001
SB instrumental attitudes ↔ SB PBC	-	.077	.051	−.016	.177	.106
SB instrumental attitudes ↔ SB habit	-	.029	.040	−.047	.122	.475
SB subjective norms ↔ SB PBC	-	.102	.067	−.031	.233	.132
SB PBC ↔ SB habit	-	−.224	.075	−.373	−.079	.002
SB subjective norms ↔ SB habit	-	.197	.068	.065	.332	.004
SB behavior ↔ PA behavior	-	.307	.066	.180	.437	<.001
SB intention ↔ SB habit	-	−.127	.052	−.230	−.028	.013
Indirect and total effects						
SB affective attitudes → SB behavior	-	.002	.019	−.056	.101	.189
SB instrumental attitudes → SB intention → SB behavior	-	.067	.029	.001	.119	.035
SB subjective norms → SB intention → SB behavior	-	−.003	.017	−.018	.036	.576
SB PBC → SB intention → SB behavior	-	.130	.044	.003	.217	.035
SB PBC → SB behavior (total)	-	.359	.067	.241	.518	<.001
SB affective attitudes → PA behavior	-	.001	.012	−.041	.012	.362
SB instrumental attitudes → SB intention → PA behavior	-	.038	.025	−.020	.094	.243

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TABLE 2 (Continued)

Path	Prior	Post. Mean	Post. *SD*	.050 *HPD*	.950 *HPD*	*p eqv.*
SB subjective norms → SB intention → PA behavior	-	−.002	.010	−.014	.025	.668
SB PBC → SB intention → PA behavior	-	.073	.044	−.039	.176	.243
SB PBC → PA behavior (total)	-	.312	.069	.186	.464	<.001

Note: SB refers to sedentary behavior, PA refers to physical activity, and PBC refers to perceived behavioral control. All standard deviations for prior means = 1.661. *p eqv*. refers to the estimated equivalent *p*-value as determined by the proportion of iterations in which the parameter estimate was in the same direction as the median parameter estimate.

DISCUSSION

To date, limited research has explored the psychological determinants of sedentary behavior and physical activity within an office-based working population. The aim of the current study was to assess the effects of a dual processing approach on limiting sedentary behavior and engaging in physical activity within a sedentary population. The current study used the constructs of an extended TPB to represent the reasoned pathway, with habit representing the automatic pathway.

Firstly, in line with previous research, it was hypothesized that instrumental attitude (H1a), affective attitude (H1b), subjective norm (H1c), and perceived behavioral control (H1d) would directly and positively predict intention to limit sedentary behavior. This hypothesis was partially supported, with instrumental attitude and perceived behavioral control having a significant positive effect on intention to limit sedentary behavior. Contrary to predictions, affective attitude did not have a significant influence on intention to limit sedentary behavior. A possible explanation for the lack of effect of affective attitude might be related to the environment. Given participants were asked to reflect upon their movement within their workday, participants may be more inclined to think of their movements as purposeful, or task oriented, as opposed to being pleasurable. This supports the qualitative findings of Edmunds et al. (2013) who explored participants' attitudes and beliefs towards physical activity within the workplace. Participants in their study discussed more social physical activities as fun and enjoyable in comparison with physical activity completed as a part of their workday. While it was expected from the TPB that subjective norm would have an effect on intention to limit sedentary behavior, no effect was found in the current study. While this is inconsistent with theory, findings of weak or null effects of subjective norm on intentions to be active or sedentary are not uncommon (Conner et al., 2015; Phipps et al., 2021), and recent meta-analyses have shown subjective norm to be the weakest construct within the theory (McEachan et al., 2011). This suggests that within the context of physical activity and sedentary behavior within the workplace, it appears that people do not rely on the approval or disapproval to inform their behavior. Thus, in combination with previous findings (Hamilton et al., 2020; McEachan et al., 2011; Prapavessis et al., 2015), the current findings add to debates as to whether subjective norm is a useful construct in explaining active lifestyles (Rhodes & Nigg, 2011).

In following with the TPB and in support of our hypothesis, it was found that perceived behavioral control had a direct and positive effect on limiting sedentary behavior (H2b) and engaging in physical activity (H3b). These findings highlight the value of perceived behavioral control based interventions within this population. Furthermore, it was hypothesized that intention to limit sedentary behavior would directly and positively predict limiting sedentary behavior (H2a) as well as directly and positively predict engaging in physical activity (H3a). In line with the TPB, intention showed to have a significant effect on limiting sedentary behavior. However, intention to limit sedentary behavior was found to have no effect on engaging in physical activity. A possi-

ble explanation to these findings was presented by Webber et al. (2020), where they found that participants were more inclined to discuss techniques relating to higher intensity physical activity, as opposed to engaging in light physical activity, as a way to break up their sedentary behavior. Such findings suggest that when thinking about limiting sedentary behavior at the workplace, people may not consider increasing their general movement to increase their overall physical activity levels. This highlights the importance for educational programs to emphasize the benefits of light physical activity and offer suggestions of activities that can be easily implemented within the environment. Given the current study measured physical activity broadly, it explores the transfer between sedentary behavior and physical activity. However future explorations of this movement transfer hypotheses would benefit from focused assessments of specific movement behaviors (i.e. standing, light physical activity, or moderate-to-vagarious physical activity).

Lastly, the current study sought to apply a dual process approach to understanding limiting sedentary behavior during the workday among a sedentary population. As such, habit was used to represent the automatic pathway within this model. It was hypothesized that habit to engage in sedentary behavior would have a direct and negative effect on limiting sedentary behavior (H4a) and engaging in physical activity (H4b). Although in the expected negative direction, the relationship between sedentary behavior habits and limiting sedentary behavior was not significantly different from zero. Furthermore, as expected, habit to engage in sedentary behavior had a significant negative effect on engaging in physical activity. In other words, the stronger the habit to be sedentary during the workday, the less time spent engaging in physical activity. Practical implications of these findings suggest the potential efficacy of habit-based strategies for reducing time spent being sedentary in the workplace, such as building pro-physical activity cues into office layouts and environmental restructuring and architecture design that promotes physical movement (Gardner et al., 2016; Spence et al., 2017).

Based on the current findings, it appears that within this population group there is a differing effect of attitude in comparison with previous literature (Lithopoulos et al., 2020). Previous literature has shown support for affective attitude over instrumental attitude for behaviors relating to physical movement (French et al., 2005; Lowe et al., 2002; Magnan et al., 2013; Rhodes et al., 2009). However, within the current study, instrumental attitude appeared to have an effect over and above that of affective attitude, suggesting that office workers may be more inclined to associate movement within the workplace as useful. A further exploration of the beliefs within this population group is needed to gain a deeper understanding of the relationship between these variables within this population. Furthermore, the current findings show support for habit to be included in models predicting both limiting sedentary behavior and engaging in physical activity. The current study provides valuable insight into how an extended TPB can be applied within this population group and the effect of these constructs on sedentary behavior and physical activity.

Strengths, limitations, and future directions

The current study has several strengths including being one of the first investigations to include a variety of workplace environments: commercial office, home office, and a combination of both. The current paper controlled for effects based on these environments. Within a COVID-19 society, it is important to consider the influence of different working environments on these psychological constructs to broaden the generalizability towards flexible work arrangements. Furthermore, the current study explored the effects of both affective and instrumental attitude on sedentary behavior within this population and context. Given the current findings, it appears that a difference exists between this population and the general population with regards to atti-

tude towards limiting sedentary behavior and engaging in physical activity. As a substantial portion of Western life is spent working (Australian Bureau of Statistics, 2020b), it is important to understand how health behaviors can be targeted within a work context. The current study offers a novel approach, by exploring varied work environments, to targeting the health behaviors of sedentary behavior and physical activity within a sedentary population. Based on these strengths, the current study offers practical implications for individuals and organisations alike who are aiming to decrease the amount of sedentary behavior or increase physical movement performed during the workday. The current study highlights the importance of instrumental attitudes towards promoting healthy activity levels in the workplace, a novel finding in comparison with the relatively weak or null effects of instrumental attitudes on leisure time physical activity (Conner et al., 2011; Phipps et al., 2021). Therefore, while previous evidence suggests messages targeting mood and emotion-based benefits of activity may be most efficacious for promoting greater physical activity, current findings suggest emphasizing the benefits and utility regarding movement, such as increased productivity and reduced likelihood of adverse health outcomes, may be more useful messaging strategies for decreasing sedentarism in office workers.

There are also study limitations that need to be considered when interpreting the results. First, although participants self-reported as full-time office workers, a substantial proportion were recruited from a University first-year participant pool, meaning that whilst working full time, participants were also undertaking between one to four units of undergraduate studies. While undertaking studies while working full time is not uncommon (Australian Bureau of Statistics, 2020a), it is possible the recruited sample may differ from the general working population given the extra commitment needed on university studies. Replication of the current study is recommended with other sedentary populations, such as school or university aged people to understand whether the current findings are generalizable or specific to office working population. Second, despite similar measures having good evidence for their validity and have demonstrated good correspondence with objective measures (Hamilton et al., 2012; Innerd et al., 2015), concerns around recall or self-report bias remain. Future studies should aim to use objective measurements of behavior, such as pedometers, accelerometers, and heart rate monitors. Third, the current study used a short follow-up timeframe in attempt to account for recall bias related to the behavior of limiting sedentary behavior (Atkin et al., 2012; Marconcin et al., 2021; Pannucci & Wilkins, 2010; Tudor-Locke & Myers, 2001). Future studies should endeavor to replicate current findings using longer follow-up periods. Finally, it is important to note that these interpretations of results are based upon theoretical considerations (Ajzen, 1991; Brand & Ekkekakis, 2018; Strack & Deutsch, 2004), and assertions of causality cannot be drawn. This is of particular note given there are also theoretical longitudinal effects between the determinants of behavior, such as the effect of positive emotion and habit development. Thus, research with experimental designs or longer time lags is also needed to test causal relationships in the proposed model whilst also investigating the potential for more complex, bidirectional and longitudinal effects. With these limitations in mind, caution around interpreting the results need to be taken. Future research may seek to further investigate these effects using longitudinal or experimental designs whilst taking into consideration potential confounding factors of the current study (e.g. age, gender, working hours, and job nature).

CONCLUSIONS

The current study sought to understand the influence of an extended TPB that includes habit, as well as the instrumental and affective components of an attitude, on reducing sedentary behavior within the workplace environment. In line with the TPB, we found that instrumen-

tal attitudes and perceived behavioral control directly influenced intention and that intention and perceived behavioral control directly predicted limiting sedentary behavior. The current study did not find support for affective attitudes and subjective norms influence on intention. Furthermore, perceived behavioral control but not intention was found to predict engaging in physical activity, with habit having a significant negative effect on engaging in physical activity. These findings indicate that within this population and context, instrumental attitudes appear to be more influential to these behaviors within an office working population. The current study also highlights the need to explore the feasibility and barriers towards increasing movement within the workplace to gain a deeper understanding of how health promotion campaigns can be implemented within this population. In conclusion, the current study supports the notion for using an extended TPB and including habit in in behavior change models targeting sedentary behavior and physical activity.

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CONFLICT OF INTEREST STATEMENT

There are no conflicts of interest or funding sources to declare.

DATA AVAILABILITY STATEMENT

Data are available at https://osf.io/jkdra/?view_only=96cf622a36e54d02a455e4ffa016e6b9.

ETHICS STATEMENT

Full ethical approval for this project was granted by the Griffith University Human Research Ethics Committee (GU:2020/401).

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REFERENCES

Ajzen, I. (1991). The theory of planned behavior. *Organizational Behavior and Human Decision Processes*, *50*(2), 179–211. https://doi.org/10.1016/0749-5978(91)90020-T

Ajzen, I. (2002). *Constructing a TPB questionnaire: Conceptual and methodological considerations*. CiteSeer.

Allison, P. D. (2001). *Missing data*. SAGE Publications.

Atkin, A. J., Gorely, T., Clemes, S. A., Yates, T., Edwardson, C., Brage, S., Salmon, J., Marshall, S. J., & Biddle, S. J. (2012). Methods of measurement in epidemiology: Sedentary behaviour. *International Journal of Epidemiology*, *41*(5), 1460–1471. https://doi.org/10.1093/ije/dys118

Australian Bureau of Statistics. (2018). National Health Survey: First results, 2017–18.

Australian Bureau of Statistics. (2020a). Education and work, Australia. https://www.abs.gov.au/statistics/people/education/education-and-work-australia/may-2020#engagement-in-employment-and-or-education

Australian Bureau of Statistics. (2020b). Insights into hours worked. https://www.abs.gov.au/articles/insights-hours-worked#where-to-find-hours-worked-data

Biddle, S. J., Gorely, T., Marshall, S. J., Murdey, I., & Cameron, N. (2004). Physical activity and sedentary behaviours in youth: Issues and controversies. *The Journal of the Royal Society for the Promotion of Health*, *124*(1), 29–33. https://doi.org/10.1177/146642400312400110

Borodulin, K., Laatikainen, T., Juolevi, A., & Jousilahti, P. (2008). Thirty-year trends of physical activity in relation to age, calendar time and birth cohort in Finnish adults. *European Journal of Public Health*, *18*(3), 339–344. https://doi.org/10.1093/eurpub/ckm092

Brand, R., & Ekkekakis, P. (2018). Affective–reflective theory of physical inactivity and exercise. *German Journal of Exercise and Sport Research*, *48*(1), 48–58. https://doi.org/10.1007/s12662-017-0477-9

Brierley, M. L., Chater, A. M., Smith, L. R., & Bailey, D. P. (2019). The effectiveness of sedentary behaviour reduction workplace interventions on cardiometabolic risk markers: A systematic review. *Sports Medicine*, *49*(11), 1739–1767. https://doi.org/10.1007/s40279-019-01168-9

Brownson, R. C., Boehmer, T. K., & Luke, D. A. (2005). Declining rates of physical activity in the United States: What are the contributors? *Annual Review of Public Health*, *26*, 421–443. https://doi.org/10.1146/annurev.publhealth.26.021304.144437

Cain, M. K., & Zhang, Z. (2019). Fit for a Bayesian: An evaluation of PPP and DIC for structural equation modeling. *Structural Equation Modeling: A Multidisciplinary Journal*, *26*(1), 39–50. https://doi.org/10.1080/10705511.2018.1490648

Commissaris, D. A. C. M., Huysmans, M. A., Mathiassen, S. E., Srinivasan, D., Koppes, L. L. J., & Hendriksen, I. J. M. (2016). Interventions to reduce sedentary behavior and increase physical activity during productive work: A systematic review. *Scandinavian Journal of Work, Environment and Health*, *42*(3), 181–191. https://doi.org/10.5271/sjweh.3544

Conner, M., McEachan, R., Taylor, N., O'Hara, J., & Lawton, R. (2015). Role of affective attitudes and anticipated affective reactions in predicting health behaviors. *Health Psychology*, *34*(6), 642–652. https://doi.org/10.1037/hea0000143

Conner, M., Rhodes, R. E., Morris, B., McEachan, R., & Lawton, R. (2011). Changing exercise through targeting affective or cognitive attitudes. *Psychology and Health*, *26*(2), 133–149. https://doi.org/10.1080/08870446.2011.531570

Conroy, D. E., Maher, J. P., Elavsky, S., Hyde, A. L., & Doerksen, S. E. (2013). Sedentary behavior as a daily process regulated by habits and intentions. *Health Psychology*, *32*(11), 1149–1157. https://doi.org/10.1037/a0031629

Crites, S. L. Jr., Fabrigar, L. R., & Petty, R. E. (1994). Measuring the affective and cognitive properties of attitudes: Conceptual and methodological issues. *Personality and Social Psychology Bulletin*, *20*(6), 619–634. https://doi.org/10.1177/0146167294206001

Depaoli, S., Clifton, J. P., & Cobb, P. R. (2016). Just another Gibbs sampler (JAGS) flexible software for MCMC implementation. *Journal of Educational and Behavioral Statistics*, *41*(6), 628–649. https://doi.org/10.3102/1076998616664876

Depaoli, S., & Van de Schoot, R. (2017). Improving transparency and replication in Bayesian statistics: The WAMBS-Checklist. *Psychological Methods*, *22*(2), 240–261. https://doi.org/10.1037/met0000065

Dugdill, L., Brettle, A., Hulme, C., McCluskey, S., & Long, A. (2008). Workplace physical activity interventions: A systematic review. *International Journal of Workplace Health Management*, *1*(1), 20–40. https://doi.org/10.1108/17538350810865578

Edmunds, S., Hurst, L., & Harvey, K. (2013). Physical activity barriers in the workplace: An exploration of factors contributing to non-participation in a UK workplace physical activity intervention. *International Journal of Workplace Health Management*, *6*(3), 227–240. https://doi.org/10.1108/IJWHM-11-2010-0040

Ekelund, U., Steene-Johannessen, J., Brown, W. J., Fagerland, M. W., Owen, N., Powell, K. E., Bauman, A., Lee, I.-M., Lancet Physical Activity Series 2 Executive Committee, & Lancet Sedentary Behaviour Working Group. (2016). Does physical activity attenuate, or even eliminate, the detrimental association of sitting time with mortality? A harmonised meta-analysis of data from more than 1 million men and women. *The Lancet*, *388*(10051), 1302–1310. https://doi.org/10.1016/S0140-6736(16)30370-1

Emanuele, P. (2008). Deep vein thrombosis. *AAOHN Journal*, *56*(9), 389–394. https://doi.org/10.3928/08910162-20080901-02

French, D. P., Sutton, S., Hennings, S. J., Mitchell, J., Wareham, N. J., Griffin, S., Hardeman, W., & Kinmonth, A. L. (2005). The importance of affective beliefs and attitudes in the theory of planned behavior: Predicting

intention to increase physical activity. *Journal of Applied Social Psychology*, *35*(9), 1824–1848. https://doi.org/10.1111/j.1559-1816.2005.tb02197.x

Gardner, B. (2012). Habit as automaticity, not frequency. *European Health Psychologist*, *14*(2), 32–36.

Gardner, B. (2015). A review and analysis of the use of 'habit' in understanding, predicting and influencing health-related behaviour. *Health Psychology Review*, *9*(3), 277–295. https://doi.org/10.1080/17437199.2013.876238

Gardner, B., Abraham, C., Lally, P., & de Bruijn, G.-J. (2012). Towards parsimony in habit measurement: Testing the convergent and predictive validity of an automaticity subscale of the Self-Report Habit Index. *International Journal of Behavioral Nutrition and Physical Activity*, *9*(1), 102. https://doi.org/10.1186/1479-5868-9-102

Gardner, B., de Bruijn, G.-J., & Lally, P. (2011). A systematic review and meta-analysis of applications of the self-report habit index to nutrition and physical activity behaviours. *Annals of Behavioral Medicine*, *42*(2), 174–187. https://doi.org/10.1007/s12160-011-9282-0

Gardner, B., Smith, L., Lorencatto, F., Hamer, M., & Biddle, S. J. (2016). How to reduce sitting time? A review of behaviour change strategies used in sedentary behaviour reduction interventions among adults. *Health Psychology Review*, *10*(1), 89–112. https://doi.org/10.1080/17437199.2015.1082146

Garnier-Villarreal, M., & Jorgensen, T. D. (2020). Adapting fit indices for Bayesian structural equation modeling: Comparison to maximum likelihood. *Psychological Methods*, *25*(1), 46–70. https://doi.org/10.1037/met0000224

Gelman, A., & Rubin, D. B. (1992). Inference from iterative simulation using multiple sequences. *Statistical Science*, *7*(4), 457–472. https://doi.org/10.1214/ss/1177011136

Hagger, M. S. (2019). Habit and physical activity: Theoretical advances, practical implications, and agenda for future research. *Psychology of Sport and Exercise*, *42*, 118–129. https://doi.org/10.1016/j.psychsport.2018.12.007

Hagger, M. S., & Chatzisarantis, N. L. (2009). Integrating the theory of planned behaviour and self-determination theory in health behaviour: A meta-analysis. *British Journal of Health Psychology*, *14*(2), 275–302. https://doi.org/10.1348/135910708X373959

Hamburg, N. M., McMackin, C. J., Huang, A. L., Shenouda, S. M., Widlansky, M. E., Schulz, E., Gokce, N., Ruderman, N. B., Keaney, J. F. Jr., & Vita, J. A. (2007). Physical inactivity rapidly induces insulin resistance and microvascular dysfunction in healthy volunteers. *Arteriosclerosis, Thrombosis, and Vascular Biology*, *27*(12), 2650–2656. https://doi.org/10.1161/ATVBAHA.107.153288

Hamilton, K., Fraser, E., & Hannan, T. (2019). Habit-based workplace physical activity intervention: A pilot study. *Occupational Medicine*, *69*(7), 471–474. https://doi.org/10.1093/occmed/kqz119

Hamilton, K., Gibbs, I., Keech, J., & Hagger, M. (2018). Predicting heavy episodic drinking in young Australian university students: A dual process approach. *Annals of Behavioral Medicine*, *52*, S181–S181. <Go to ISI>://WOS:000431185200433.

Hamilton, K., van Dongen, A., & Hagger, M. S. (2020). An extended theory of planned behavior for parent-for-child health behaviors: A meta-analysis. *Health Psychology*, *39*(10), 863–878. https://doi.org/10.1037/hea0000940

Hamilton, K., White, K. M., & Cuddihy, T. (2012). Using a single-item physical activity measure to describe and validate parents' physical activity patterns. *Research Quarterly for Exercise and Sport*, *83*(2), 340–345. https://doi.org/10.1080/02701367.2012.10599865

Hannan, T. E., Moffitt, R. L., Neumann, D. L., & Kemps, E. (2019). Implicit approach–avoidance associations predict leisure-time exercise independently of explicit exercise motivation. *Sport, Exercise, and Performance Psychology*, *8*(2), 210–222. https://doi.org/10.1037/spy0000145

Hemingway, H., Shipley, M. J., Stansfeld, S., & Marmot, M. (1997). Sickness absence from back pain, psychosocial work characteristics and employment grade among office workers. *Scandinavian Journal of Work, Environment & Health*, *23*(2), 121–129. https://doi.org/10.5271/sjweh.189

Higham, W. (2019). *The work colleague of the future: A report on the long-term health of office workers*. Fellowes.

Hitosugi, M., Niwa, M., & Takatsu, A. (2000). Rheologic changes in venous blood during prolonged sitting. *Thrombosis Research*, *100*(5), 409–412. https://doi.org/10.1016/s0049-3848(00)00348-0

Hofmann, W., Friese, M., & Wiers, R. W. (2008). Impulsive versus reflective influences on health behavior: A theoretical framework and empirical review. *Health Psychology Review*, *2*(2), 111–137. https://doi.org/10.1080/17437190802617668

Hoofs, H., van de Schoot, R., Jansen, N. W., & Kant, I. (2018). Evaluating model fit in Bayesian confirmatory factor analysis with large samples: Simulation study introducing the BRMSEA. *Educational and Psychological Measurement*, *78*(4), 537–568. https://doi.org/10.1177/0013164417709314

Innerd, P., Catt, M., Collerton, J., Davies, K., Trenell, M., Kirkwood, T. B., & Jagger, C. (2015). A comparison of subjective and objective measures of physical activity from the Newcastle 85+ study. *Age and Ageing*, *44*(4), 691–694. https://doi.org/10.1093/ageing/afv062

Janssen, I., Clarke, A. E., Carson, V., Chaput, J.-P., Giangregorio, L. M., Kho, M. E., Poitras, V. J., Ross, R., Saunders, T. J., & Ross-White, A. (2020). A systematic review of compositional data analysis studies examining associations between sleep, sedentary behaviour, and physical activity with health outcomes in adults. *Applied Physiology, Nutrition, and Metabolism*, *45*(10), S248–S257. https://doi.org/10.1139/apnm-2020-0160

Jorgensen, T. D., Garnier-Villarreal, M., Pornprasermanit, S., & Lee, J. (2019). Small-variance priors can prevent detecting important misspecifications in Bayesian confirmatory factor. In *Quantitative Psychology: 83rd Annual Meeting of the Psychometric Society*. Springer International Publishing.

Kirk, M. A., & Rhodes, R. E. (2011). Occupation correlates of adults' participation in leisure-time physical activity: A systematic review. *American Journal of Preventive Medicine*, *40*(4), 476–485. https://doi.org/10.1016/j.amepre.2010.12.015

Kruschke, J. (2014). *Doing Bayesian data analysis: A tutorial with R, JAGS, and Stan*. Elsevier. https://doi.org/10.1016/B978-0-12-405888-0.00008-8

Levy, R. (2011). Bayesian data-model fit assessment for structural equation modeling. *Structural Equation Modeling: A Multidisciplinary Journal*, *18*(4), 663–685. https://doi.org/10.1080/10705511.2011.607723

Lithopoulos, A., Kaushal, N., Beauchamp, M. R., Conner, M., de Bruijn, G. J., Latimer-Cheung, A. E., & Rhodes, R. E. (2020). Changing sedentary behavior in the office: A randomised controlled trial comparing the effect of affective, instrumental, and self-regulatory messaging on sitting. *Applied Psychology: Health and Well-Being*, *12*(3), 687–702. https://doi.org/10.1111/aphw.12202

Loh, K., & Redd, S. (2008). Understanding and preventing computer vision syndrome. *Malaysian Family Physician: The Official Journal of the Academy of Family Physicians of Malaysia*, *3*(3), 128. https://www.ncbi.nlm.nih.gov/pubmed/25606136–130.

Lowe, R., Eves, F., & Carroll, D. (2002). The influence of affective and instrumental beliefs on exercise intentions and behavior: A longitudinal analysis. *Journal of Applied Social Psychology*, *32*(6), 1241–1252. https://doi.org/10.1111/j.1559-1816.2002.tb01434.x

Lowe, S. S., Danielson, B., Beaumont, C., Watanabe, S. M., Baracos, V. E., & Courneya, K. S. (2015). Correlates of objectively measured sedentary behavior in cancer patients with brain metastases: An application of the theory of planned behavior. *Psycho-Oncology*, *24*(7), 757–762. https://doi.org/10.1002/pon.3641

Magnan, R. E., Kwan, B. M., & Bryan, A. D. (2013). Effects of current physical activity on affective response to exercise: Physical and social–cognitive mechanisms. *Psychology & Health*, *28*(4), 418–433. https://doi.org/10.1080/08870446.2012.733704

Makowski, D. (2018). The psycho package: An efficient and publishing-oriented workflow for psychological science. *Journal of Open Source Software*, *3*(22), 470. https://doi.org/10.21105/joss.00470

Makowski, D., Ben-Shachar, M. S., & Lüdecke, D. (2019). bayestestR: Describing effects and their uncertainty, existence and significance within the Bayesian framework. *Journal of Open Source Software*, *4*(40), 1541. https://doi.org/10.21105/joss.01541

Malik, S. H., Blake, H., & Suggs, L. S. (2014). A systematic review of workplace health promotion interventions for increasing physical activity. *British Journal of Health Psychology*, *19*(1), 149–180. https://doi.org/10.1111/bjhp.12052

Marconcin, P., Júdice, P. B., Ferrari, G., Werneck, A., & Marques, A. (2021). Methods of assessing sedentary behaviour. In *Sedentary behaviour—A contemporary view*. IntechOpen. https://doi.org/10.5772/intechopen.99567

Martin, A., Fitzsimons, C., Jepson, R., Saunders, D. H., van der Ploeg, H. P., Teixeira, P. J., Gray, C. M., & Mutrie, N. (2015). Interventions with potential to reduce sedentary time in adults: Systematic review and meta-analysis. *British Journal of Sports Medicine*, *49*(16), 1056–1063. https://doi.org/10.1136/bjsports-2014-094524

Matthews, C. E., Chen, K. Y., Freedson, P. S., Buchowski, M. S., Beech, B. M., Pate, R. R., & Troiano, R. P. (2008). Amount of time spent in sedentary behaviors in the United States, 2003–2004. *American Journal of Epidemiology*, *167*(7), 875–881. https://doi.org/10.1093/aje/kwm390

McEachan, R. R. C., Conner, M., Taylor, N. J., & Lawton, R. J. (2011). Prospective prediction of health-related behaviours with the theory of planned behaviour: A meta-analysis. *Health Psychology Review*, *5*(2), 97–144. https://doi.org/10.1080/17437199.2010.521684

McElreath, R. (2020). *Statistical rethinking: A Bayesian course with examples in R and Stan*. Chapman & Hall/CRC. https://doi.org/10.1201/9780429029608

Merkle, E. C., & Rosseel, Y. (2015). blavaan: Bayesian structural equation models via parameter expansion. arXiv preprint arXiv:1511.05604.

Mokdad, A. H., Forouzanfar, M. H., Daoud, F., Mokdad, A. A., El Bcheraoui, C., Moradi-Lakeh, M., Kyu, H. H., Barber, R. M., Wagner, J., & Cercy, K. (2016). Global burden of diseases, injuries, and risk factors for young people's health during 1990–2013: A systematic analysis for the Global Burden of Disease Study 2013. *The Lancet*, *387*(10036), 2383–2401. https://doi.org/10.1016/S0140-6736(16)00648-6

Nigg, C. R., Geller, K. S., Motl, R. W., Horwath, C. C., Wertin, K. K., & Dishman, R. K. (2011). A research agenda to examine the efficacy and relevance of the transtheoretical model for physical activity behavior. *Psychology of Sport and Exercise*, *12*(1), 7–12. https://doi.org/10.1016/j.psychsport.2010.04.004

Noble, N., Paul, C., Turon, H., & Oldmeadow, C. (2015). Which modifiable health risk behaviours are related? A systematic review of the clustering of Smoking, Nutrition, Alcohol and Physical activity ('SNAP') health risk factors. *Preventive Medicine*, *81*, 16–41. https://doi.org/10.1016/j.ypmed.2015.07.003

Nylander, C. (2016). *Protective factors, health-risk behaviours and the impact of coexisting ADHD among adolescents with diabetes and other chronic conditions*. Acta Universitatis Upsaliensis.

Pannucci, C. J., & Wilkins, E. G. (2010). Identifying and avoiding bias in research. *Plastic and Reconstructive Surgery*, *126*(2), 619–625. https://doi.org/10.1097/PRS.0b013e3181de24bc

Parry, S., & Straker, L. (2013). The contribution of office work to sedentary behaviour associated risk. *BMC Public Health*, *13*(1), 1–10, 296. https://doi.org/10.1186/1471-2458-13-296

Pearson, N., Braithwaite, R., Biddle, S. J., van Sluijs, E. M., & Atkin, A. J. (2014). Associations between sedentary behaviour and physical activity in children and adolescents: A meta-analysis. *Obesity Reviews*, *15*(8), 666–675. https://doi.org/10.1111/obr.12188

Phipps, D. J., Hagger, M. S., & Hamilton, K. (2020). Predicting limiting 'free sugar' consumption using an integrated model of health behavior. *Appetite*, *150*, 104668. https://doi.org/10.1016/j.appet.2020.104668

Phipps, D. J., Hannan, T. E., Rhodes, R. E., & Hamilton, K. (2021). A dual-process model of affective and instrumental attitudes in predicting physical activity. *Psychology of Sport and Exercise*, *54*, 101899. https://doi.org/10.1016/j.psychsport.2021.101899

Phipps, D. J., Rhodes, R. E., Jenkins, K., Hannan, T. E., Browning, N. G., & Hamilton, K. (2022). A dual process model of affective and instrumental implicit attitude, self-monitoring, and sedentary behavior. *Psychology of Sport and Exercise*, *62*, 102222. https://doi.org/10.1016/j.psychsport.2022.102222

Plummer, M. (2012). JAGS: Just Another Gibbs Sampler v. 3.3.0.

Prapavessis, H., Gaston, A., & DeJesus, S. (2015). The Theory of Planned Behavior as a model for understanding sedentary behavior. *Psychology of Sport and Exercise*, *19*, 23–32. https://doi.org/10.1016/j.psychsport.2015.02.001

R Core Team. (2013). *R: A language and environment for statistical computing*. R Foundation for Statistical Computing.

Rebar, A. L., Dimmock, J. A., Jackson, B., Rhodes, R. E., Kates, A., Starling, J., & Vandelanotte, C. (2016). A systematic review of the effects of non-conscious regulatory processes in physical activity. *Health Psychology Review*, *10*(4), 395–407. https://doi.org/10.1080/17437199.2016.1183505

Rebar, A. L., Gardner, B., Rhodes, R. E., & Verplanken, B. (2018). The measurement of habit. In *The psychology of habit* (pp. 31–49). Springer. https://doi.org/10.1007/978-3-319-97529-0_3

Rhodes, R., Fiala, B., & Conner, M. (2009). Affective judgments and physical activity: A review and meta-analysis. *Annals of Behavioral Medicine*, *38*(3), 180–204. https://doi.org/10.1007/s12160-009-9147-y

Rhodes, R. E. (2017). The evolving understanding of physical activity behavior: a multi-process action control approach. In *Advances in motivation science* (Vol. 4, pp. 171–205). Elsevier. https://doi.org/10.1016/bs.adms.2016.11.001

Rhodes, R. E. (2021). Multi-process action control in physical activity: A primer. *Frontiers in Psychology*, *12*, 797484. https://doi.org/10.3389/fpsyg.2021.797484

Rhodes, R. E., Cox, A., & Sayar, R. (2022). What predicts the physical activity intention–behavior gap? A systematic review. *Annals of Behavioral Medicine*, *56*(1), 1–20. https://doi.org/10.1093/abm/kaab044

Rhodes, R. E., & de Bruijn, G. J. (2013). How big is the physical activity intention–behaviour gap? A meta-analysis using the action control framework. *British Journal of Health Psychology*, *18*(2), 296–309. https://doi.org/10.1111/bjhp.12032

Rhodes, R. E., & De Bruijn, G.-J. (2010). Automatic and motivational correlates of physical activity: Does intensity moderate the relationship? *Behavioral Medicine*, *36*(2), 44–52. https://doi.org/10.1080/08964281003774901

Rhodes, R. E., & Dean, R. N. (2009). Understanding physical inactivity: Prediction of four sedentary leisure behaviors. *Leisure Sciences*, *31*(2), 124–135. Pii 908940053. https://doi.org/10.1080/01490400802685948

Rhodes, R. E., Janssen, I., Bredin, S. S., Warburton, D. E., & Bauman, A. (2017). Physical activity: Health impact, prevalence, correlates and interventions. *Psychology & Health*, *32*(8), 942–975. https://doi.org/10.1080/08870446.2017.1325486

Rhodes, R. E., McEwan, D., & Rebar, A. L. (2019). Theories of physical activity behaviour change: A history and synthesis of approaches. *Psychology of Sport and Exercise*, *42*, 100–109. https://doi.org/10.1016/j.psychsport.2018.11.010

Rhodes, R. E., & Nigg, C. R. (2011). Advancing physical activity theory: A review and future directions. *Exercise and Sport Sciences Reviews*, *39*(3), 113–119. https://doi.org/10.1097/JES.0b013e31821b94c8

Roberts, V., Maddison, R., Magnusson, J., & Prapavessis, H. (2010). Adolescent physical activity: Does implementation intention have a role? *Journal of Physical Activity and Health*, *7*(4), 497–507. https://doi.org/10.1123/jpah.7.4.497

Ross, R., Chaput, J.-P., Giangregorio, L. M., Janssen, I., Saunders, T. J., Kho, M. E., Poitras, V. J., Tomasone, J. R., El-Kotob, R., & McLaughlin, E. C. (2020). Canadian 24-hour movement guidelines for adults aged 18–64 years and adults aged 65 years or older: An integration of physical activity, sedentary behaviour, and sleep. *Applied Physiology, Nutrition, and Metabolism*, *45*(10), S57–S102. https://doi.org/10.1139/apnm-2020-0467

Salmon, J., Owen, N., Crawford, D., Bauman, A., & Sallis, J. F. (2003). Physical activity and sedentary behavior: A population-based study of barriers, enjoyment, and preference. *Health Psychology*, *22*(2), 178–188. https://doi.org/10.1037//0278-6133.22.2.178

Spence, J. C., Rhodes, R. E., & Carson, V. (2017). Challenging the dual-hinge approach to intervening on sedentary behavior. *American Journal of Preventive Medicine*, *52*(3), 403–406. https://doi.org/10.1016/j.amepre.2016.10.019

Stevens, C. J., Baldwin, A. S., Bryan, A. D., Conner, M., Rhodes, R. E., & Williams, D. M. (2020). Affective determinants of physical activity: A conceptual framework and narrative review. *Frontiers in Psychology*, *11*, 3366. https://doi.org/10.3389/fpsyg.2020.568331

Strack, F., & Deutsch, R. (2004). Reflection and impulse as determinants of conscious and unconscious motivation. *Social Motivation: Conscious and Unconscious Processes*, 91–112. https://doi.org/10.1017/CBO9780511735066.008

Straker, L., & Mathiassen, S. E. (2009). Increased physical work loads in modern work–a necessity for better health and performance? *Ergonomics*, *52*(10), 1215–1225. https://doi.org/10.1080/00140130903039101

Symons Downs, D., & Hausenblas, H. (2005). Exercise behavior and the theories of reasoned action and planned behavior: A meta-analytic update. *Journal of Physical Activity and Health*, *2*, 76–97. https://doi.org/10.1123/jpah.2.1.76

Triandis, H. C. (1977). *Interpersonal behavior*. Brooks/Cole Publishing Company.

Tudor-Locke, C. E., & Myers, A. M. (2001). Challenges and opportunities for measuring physical activity in sedentary adults. *Sports Medicine*, *31*(2), 91–100. https://doi.org/10.2165/00007256-200131020-00002

Warburton, D. E., & Bredin, S. S. (2017). Health benefits of physical activity: A systematic review of current systematic reviews. *Current Opinion in Cardiology*, *32*(5), 541–556. https://doi.org/10.1097/HCO.0000000000000437

Webber, S. C., Ripat, J. D., Pachu, N. S., & Strachan, S. M. (2020). Exploring physical activity and sedentary behaviour: Perspectives of individuals with osteoarthritis and knee arthroplasty. *Disability and Rehabilitation*, *42*(14), 1971–1978. https://doi.org/10.1080/09638288.2018.1543463

World Health Organization. (1998). *Obesity: preventing and managing the global epidemic: Report of a WHO consultation on obesity*. World Health Organization.

World Health Organization. (2015). *World health statistics 2015*. World Health Organization.

World Health Organization. (2020). Physical activity. https://www.who.int/en/news-room/fact-sheets/detail/physical-activity

Zwart, S. R., Hargens, A. R., Lee, S. M., Macias, B. R., Watenpaugh, D. E., Tse, K., & Smith, S. M. (2007). Lower body negative pressure treadmill exercise as a countermeasure for bed rest-induced bone loss in female identical twins. *Bone*, *40*(2), 529–537. https://doi.org/10.1016/j.bone.2006.09.014

SUPPORTING INFORMATION

Additional supporting information can be found online in the Supporting Information section at the end of this article.

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