Academic Journal of Health Sciences & Research

Iris Publishers

Research Article

Promoting Physical Activity Participation among Inactive University PhD Students using Educational and Implementation Intentions Interventions

Lawrence Bismarck Ndupu[1]*, Natalie Quinn-Walker[2] and Kathryn Szymanska Barrett[1]

[1]*Public Health Department, School of Health and Care, Coventry University, UK*

[2]*Public Health Department, Birmingham City University, Birmingham, UK*

Corresponding author: Lawrence Ndupu, Public Health Department, School of Health and Care, Coventry University, UK

Received Date: May 19, 2025

Published Date: May 26, 2025

Abstract

Background: Physical inactivity is prevalent among university PhD students, impacting their health and well-being. This study explores the effectiveness of combining educational and intention-based interventions to promote physical activity among inactive PhD students.

Objectives: To assess whether improving knowledge about physical activity and/or intentions to engage in physical activity increases physical activity levels among inactive PhD students.

Methods: A 4-week pre-post study design was employed, involving 67 PhD students (age 36.45± 8.58, 31 male/36 female) from a university in the East Midlands in the United Kingdom. Participants were randomly assigned to four groups: education and intentions, education only, intentions only, and control. Interventions included educational materials and implementation intentions templates. Outcome measures were taken at baseline and post-intervention, assessing physical activity levels, knowledge, and intentions.

Results: Participants in the education and intentions group showed the highest increase in total physical activity levels and time spent in physical activity weekly (1067.6 ± 140.94 MET-minutes/week and 194.9± 6.76 minutes/week), followed by the intentions only (1039.0 ± 156.44 MET-minutes/week and 179.9 ± 7.50 minutes/week), education only (874.4 ± 136.73 MET-minutes/week and 174.8 ± 6.56 minutes/week), and control (483.8 ± 145.03 MET-minutes/week and131.0 ± 6.95 minutes/week) groups. No significant gender differences were found in total physical activity levels, but males spent more time in physical activity weekly. Higher knowledge about physical activity benefits and risks (Level 4 knowledge) was associated with increased physical activity engagement.

Conclusion: Combining educational and intentions-based interventions effectively increases physical activity levels among inactive PhD students. Future interventions should integrate knowledge about the risks of physical inactivity and consider gender differences in physical activity engagement.

Keywords: Physical activity; PhD students; Educational Intervention; Implementation Intentions; Behavior Change; University

Abbreviations: BCW: Behavior Change Wheel; BIQ: Behavioral Intentions Questionnaire; COM-B: Capability Opportunity, Motivation-Behavior; GPAQ: Global Physical Activity Questionnaire; LKPAHQ: Levels of Knowledge of Physical Activity for Health Questionnaire; MET: Metabolic Equivalent of Task; PA: Physical Activity; PBQ: Past Behavior Questionnaire; TDF: Theoretical Domains Framework

Introduction

Physical inactivity is a major risk factor for chronic diseases such as type 2 diabetes, coronary heart disease, hypertension, stroke, depression and anxiety, osteoarthritis, rheumatoid arthritis, and colon, breast, and endometrial cancer [1]. Even with these detrimental effects, nearly 31% of the adult population globally (i.e., 1.8 billion adults) are still physically inactive [2]. Therefore, it is imperative to implement innovative strategies to enhance physical activity (PA) levels among adults. Previous studies conducted within a university setting suggested that PhD students tend to be more physically inactive compared to other students, possibly due to pressures of trying to balance research and work commitments [3]. The significant barriers identified were a lack of knowledge about the recommended physical activity guidelines for adults and a lack of intention to engage in PA [4]. This is aligned with other studies indicating that the knowledge about the recommended PA levels, the benefits of PA and the detrimental impacts of PA are generally low among adults [5,6]. For example Hunter, et al. [7] investigated the correlates of awareness about the PA recommendations in the UK and revealed that approximately 47.0% of respondents were unaware of the PA recommendations. In support of this finding, a study carried out in England indicated that nearly two-thirds (62.3%) of adults failed to provide any estimate of the PA guidelines [6]. There have been conflicting findings regarding the association between awareness about the PA recommendations and actual PA engagement [8-10]. A likely reason for the conflicting findings may be that the knowledge of PA recommended guidelines does not directly impact on behavior; individuals must first develop intentions to engage in PA.

On the other hand, several interventions have employed the improvement of knowledge about PA as an efficacious approach to raise levels of PA in universities. For example, the findings of a study conducted by Ghaffari, et al. [11] among university students suggested that the educational intervention resulted in a considerable rise in the average scores of knowledge, attitude and PA immediately after the intervention and at one-month follow-up. Consistent with this study, previous research [12,13] demonstrated that the awareness about PA was positively associated with PA levels. Therefore, implementing educational interventions to raise awareness about PA among inactive PhD students may effectively enhance their PA. Additionally, intentions to engage in physical activity have been shown to influence actual participation in PA [5].

Intentions are conscious resolutions to perform a behavior or a determination to act in a specific manner [14]. While having a strong intention does not always lead to the enactment of behavior, strong evidence indicates that forming implementation intentions increases the possibility of performing the specified behavior [15,16]. The implementation intentions concept is a volitional approach that has increasingly gained experiential support in recent years [17]. Over the years, numerous studies have demonstrated the effectiveness of implementation intentions in promoting stair use [18] and increasing PA and exercise [19-21]. For example, a study by Murray, Rodgers & Fraser [21] that examined the impact of implementation intentions on an exercise intervention among university students in Canada indicated that implementation intentions may help sustain adherence and self-efficacy in engaging in exercise. This suggests that forming an implementation intention regarding where, when, and how to engage in physical activity will increase the likelihood of participation. In general, interventions that employ implementation intentions to increase PA engagement typically last between 2 to 4 weeks [19,22,23]. The present study sought to investigate whether enhancing knowledge about PA and/or intentions to participate in PA would increase PA levels among inactive PhD students.

Materials and Methods

Participants

The approval for this study was obtained from the College of Life and Natural Sciences Ethics Committee at the University of Derby, United Kingdom (ETH1819-0099). Each participant provided written informed consent before participation. Sixty-seven physically inactive PhD students (females= 36, males= 31; mean age 36.45± 8.58) with no underlying disease preventing them from engaging in routine PA participated in this study as illustrated in Table 1. All participants were current postgraduate students at the University of Derby in the United Kingdom.

Table 1: Socio-demographic characteristics of the PhD students.

	Intervention Groups				All (N=67)
	EIG (N=17)	EG (N=18)	IG (N=16)	CG (N=16)	
Age (years), mean (SD)	34.2 ± 8.43	40.4 ± 10.51	37.3± 8.20	33.5 ± 4.57	36.45± 8.58
Gender					
Male	9 (56.0%)	9 (50.0%)	5 (31.2%)	8 (50.0%)	31 (46.0%)
Female	8(44.0%)	9 (50.0%)	11 (68.8%)	8 (50.0%)	36 (54.0%)
Ethnicity					
White	9 (52.9%)	13 (72.2%)	11 (68.7%)	13 (81.0%)	46 (68.7%)
Black/African/Caribbean/Black	4 (23.5%)	3 (16.6%)	2 (12.5%)	1 (6.0%)	10 (14.9%)
British	2 (11.8%)	1 (5.6%)	3 (18.8%)	2 (13.0%)	8 (11.9%)

Asian/Asian British	-	-	-	-	-
Mixed/Multiple ethnic groups	2 (11.8%)	1(5.6%)	-	-	3 (4.5%)
Other ethnic groups	-	-		-	-
Study type					
Full-time	13 (76.5%)	13 (72.2%)	14 (87.5%)	13 (81.0%)	53 (79%)
Part-time	4 (23.5%)	5 (27.8%)	2 (12.5%)	3 (19.0%)	14 (21%)

Table Abbreviations: CG: Control group; EG: Education only group; EIG: Education and intervention group; IG: Intervention only group; SD: Standard deviation

Inclusion and exclusion criteria

Current PhD students at the University of Derby who are 18 years and over and scored below 600 MET- min/week of moderate intensity PA, as measured by the Global Physical Activity Questionnaire (GPAQ), were included in the study. PhD students who are engaged in temporary work within the administrative centres were classified as PhD students. Anybody who did not meet the mentioned inclusion criteria were excluded from the study. Furthermore, any PhD student with possible medical contraindications to routine PA, as measured by the Health Screening Questionnaire, was excluded from this study except a clearance is obtained from their GP.

Procedures

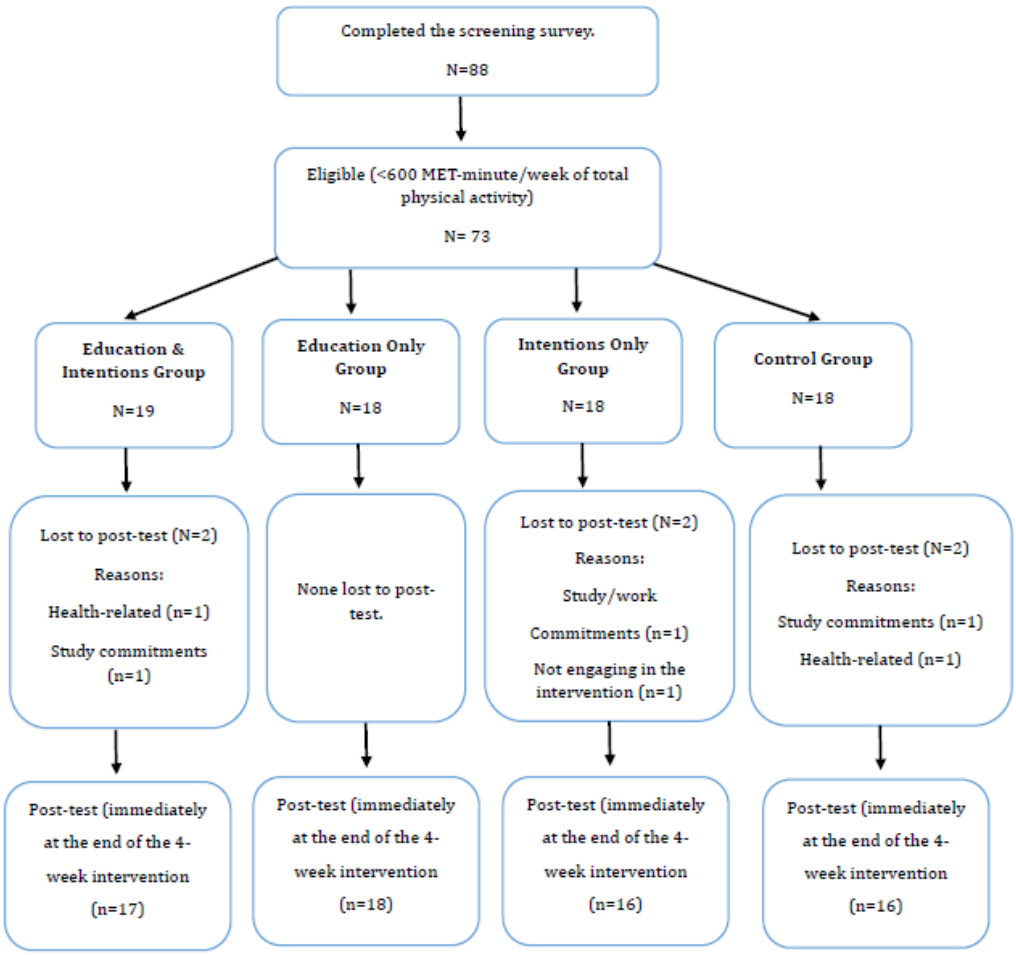

Figure 1: Flow chart showing the recruitment and randomization of participants into the intervention groups.

The participants were randomly allocated to one of four intervention groups: education and intentions group (n = 19), education-only group (n = 18), intentions-only group (n = 18), and control group (n = 18). Among the participants assigned to different treatment groups, six withdrew at baseline, i.e., two each from the education and intentions, intentions, and control groups. The reasons for withdrawal are shown in Figure 1. This 4-week behavior change intervention focused on increasing the participants' knowledge about the PA recommended guidelines, benefits of PA and detrimental impacts of physical inactivity, as well as the intentions to engage in PA, with the specific objective of improving their overall PA levels.

Following the collection of the baseline measures, the educational and/or intervention interventions were delivered based on the group participants to were assigned. The education and intentions group were sent both educational materials to read, and the implementation intentions, and the If-Then templates to plan days, times and places they intend to engage in PA, as well as to plan how to overcome possible barriers; the educational group were sent only educational materials once; and the intentions group were sent the implementation intentions and the If-Then templates and requested to use them to plan days, times and places they intend to engage in PA and also plan how they intend to overcome possible barriers. However, the control group were not given any intervention but requested to carry on with their usual routine.

The educational intervention involved the presentation of educational information about PA (i.e., PA recommended guidelines, the benefits of PA, the detrimental impact of physical inactivity and ways to achieve the recommended PA levels) delivered once at the beginning of the intervention [24]. The intentions intervention involved providing the participants with a template to form their weekly implementation intentions with regards to when, where and how they would engage in PA. The If-Then template was also provided to the participants to help them plan their weekly PA and how to overcome possible barriers weekly for the four weeks of the intervention [19,23]. Participants in all four treatment groups were requested to complete weekly activity logs during the intervention period. Furthermore, weekly e-mail reminders were sent to all participants in the different treatment groups. After the study ended, the participants were sent the post-intervention survey to complete. Then the participants in the control group were sent all the intervention materials that were given to participants in the different treatment groups.

Outcome measures

The following three outcomes were measured in this study:

Knowledge about the recommended physical activity level

This was measured using a two-item questionnaire that has been widely used in previous studies [6,12,24] to assess knowledge about PA. The participants were asked "Do you know what the national recommendations are for taking part in PA, in terms of minutes per week of moderate intensity PA?" The participants that respond 'no' were considered as 'don't know', as required in the protocol of this validated scale. The participants that respond 'yes' were then be asked, "what are the national recommendations for taking part in PA, in terms of minutes per week of moderate intensity PA?" Answers of 150 minutes weekly, which is in line with existing PA recommendation, were regarded as correct. Participants that provided answers below 150 minutes weekly were regarded as underestimated, while those that provided answers above 150 minutes weekly were regarded as overestimated [6].

Levels of awareness of physical activity for health

This was assessed employing the Levels of Knowledge of Physical Activity for Health Questionnaire (LKPAHQ), which was previously used by Fredriksson, et al. [5]. This questionnaire classified the knowledge of PA into four levels. Level 1 measured the awareness that PA has health benefits, while physical inactivity has a detrimental impact on health. For example, level 1 awareness evaluated participants with the following two questions. The first question was, 'In your opinion, is participating in regular PA beneficial for people's health? 'Would you say that it is?' (options of five responses, from 'very beneficial' to 'not beneficial at all', with lower counts indicating higher awareness). While the second question was, "In your opinion, is not participating in regular PA harmful to people's health? Would you say that it is? (options of five responses, from 'very harmful to 'not harmful at all', with lower counts indicating higher awareness). Level 2 measured the awareness of certain health problems associated with physical inactivity. For example, participants were asked to choose health problems that were associated with physical inactivity from a list of choices involving correct answers, such as high blood pressure and cardiovascular disease, and wrong answers, such as malaria. The level 2 awareness was computed as a summation of the number of health problems they appropriately detected as benefiting from improved PA. The level 3 measured the participants' exact awareness about the PA required for health and the risk reduction of developing certain chronic diseases by participating in regular PA. This level was grouped into two distinct variables represented as (a) and (b). The level 3a was measured employing multiple choice questions, with five options, of which only one was correct. For example, 'To the best of your knowledge, how much PA is sufficient to achieve health benefits in adults? Do you think it is…', with a right answer choice as '30 minutes of moderate intensity PA on 5 or more days a week' and the wrong answer choices such as ' '30 minutes of vigorous intensity PA on 2 days a week'. The level 3a was coded as 'right' or 'wrong' (i.e., a binary).

The level 3b was measured employing four items requesting participants to answer some questions, such as, 'On a range of 0-100%, by what percentage do you think participating in regular PA would reduce a person's risk of developing type II diabetes/cardiovascular disease/depression/colon cancer?' The mean responses across the four items were then calculated, and participants were coded into four categories: I do not know; underestimate (below 27.5%); correct (from 27.5% to 47.5%); and overestimate (above 47.5%). These cut-off points were founded on previous studies [25-26], which showed that the risk of developing

these diseases attributable to inactivity ranged from 30 to 45% and allowing a 2.5% possibility for miscalculation on both sides. Finally, the level 4 measured the knowledge and acceptance that the risks of physical inactivity and benefits of PA, inherent in levels 1 to 3, apply to a person's risk of developing participating in regular PA increase your risk of developing type II diabetes/cardiovascular disease/depression/colon cancer at some point during your lifetime? Five options of responses, from 'Yes, a very high risk' to 'No increased risk', were provided. Means of responses were computed to produce a level 4 awareness summary score, ranging from 1 to 5, with lower scores suggesting higher knowledge of individual risk of physical inactivity.

Intentions to engage in physical activity and past behaviors

This was measured using the Behavioral Intentions Questionnaire (BIQ) and the Past Behavior Questionnaire (PBQ) developed by Courneya & McAuley [27]. The BIQ was used to measure the intentions of the participants to engage in PA using a 4-item scale. For example, "I intend to engage in PA times during the next 4 weeks". Then the PBQ was used after four weeks to measure if the participants engaged in the PA they intended to do, using the same questions retrospectively. For example, "I engaged in PA times during the past 4 weeks".

Statistical analysis

The descriptive statistics were presented as percentages, frequencies, means and standard deviations. The minutes/week the participants spent in moderate and vigorous activities were computed using the WHO guide [28] presented as MET-minute/week. IBM SPSS statistical software 25.0 (Chicago, IL, USA) was employed to perform all statistical analyses, with the significance level set at 0.05. All the assumptions for various parametric tests were checked before each analysis, and when this was violated, the Kruskal-Wallis H non-parametric test was used. One-way ANOVAs were used to compare participants' socio-demographic characteristics at baseline across the intervention groups to ensure that randomisation was conducted correctly. Pre- and post-differences were measured using mixed-methods design ANOVA. Binary logistic regression was carried out for the dichotomous variable. Independent samples t-test was employed for categorical independent variables with two categories, while one-way ANOVA was employed for those with more than two categories. Chi-square tests were employed to compare relations between categorical variables. Finally, cross-tabulation was used to compare days, times and places specified in the implementation intentions participants formed at baseline against days, times, and areas that the PA was enacted. The effect sizes were reported as partial eta square (ηp2), using the following Cohen's classification of effect sizes: small (0.01), medium (0.06) and large (0.14) [29].

Results and Discussion

There was a significant main effect of Intervention Groups ($F_{3,59} = 3.41$, $p=0.023$, $\eta p2 =0.148$), with education and intentions group (mean= 1067.6 ± 140.94 MET-minutes/week) recording the highest Total PA levels, followed by intentions only group (mean= 1039.0 ± 156.44 MET-minutes/week), education only group (874.4 ± 136.73 MET-minutes/week) and control group (mean=483.8 ± 145.03 MET-minutes/week), as illustrated in Figure 2. In contrast, there was no significant main effect of Gender ($F_{3,59} = 0.11$, $p=0.741$, $\eta p2 =0.002$). There was also no significant interaction between Treatment Groups and Gender ($F_{3,59} = 0.42$, $p=0.738$, $\eta p2 =0.021$) on Total PA levels. The results are shown in Figure 2. Follow-up Bonferroni pairwise comparisons test indicated that there was a significant difference between pre- and post-intervention ($p<0.001$); between the education and intentions group and the control group ($P=0.03$), but there were no significant differences between the other groups ($p>0.05$). There was also no significant difference between the male and female participants ($p=0.74$).

The results indicated that even though the total PA levels increased in all intervention groups pre-post intervention, the increase was highest among the education and intentions group, followed by the intentions group, education group and control group, as illustrated in Figure 3. The descriptive statistics showing the mean total PA by intervention groups and gender is presented in Table 2. Furthermore, there was a significant main effect of Intervention Groups ($F_{3,59} = 15.75$, $p<0.001$, $\eta p^2 =0.445$), with education and intentions group (mean= 194.9 ± 6.76 minutes/week) recording the highest time spent in PA weekly, followed by intentions only group (mean=179.9 ± 7.50 minutes/week), education only group (mean= 174.8 ± 6.56 minutes/week) and control group (mean=131.0 ± 6.95 minutes/week), as illustrated in Figure 4. There was also a significant main effect of Gender ($F_{1,59} = 9.63$, $p<0.003$, $\eta p^2 =0.140$), with male participants (mean=180.9 ± 5.14) generally reporting more time spent in PA weekly than the female participants (mean=159.4 ± 4.67), as presented in Figure 5.

Table 2: Descriptive statistics showing the mean total physical activity levels for PhD students.

Intervention groups	Pre-intervention		Post-intervention	
	N	Mean (SD)	N	Mean (SD)
Education and Intentions Group				
Male	9	335.6 ± 148.59	9	1733.3 ± 669.93
Female	8	384.0 ± 128.78	8	1817.5 ± 1090.82
Total	17	358.4 ± 137.54	17	1771.9 ± 864.20
Education Only Group				
Male	9	373.3 ± 97.98	9	1666.7 ± 454.75

Female	9	328.9 ± 91.17	9	1128.9 ± 670.46
Total	18	351.1 ± 94.61	18	1397.8± 620.81
Intentions Only Group				
Male	5	400.0 ± 113.14	5	1556.0 ± 464.84
Female	11	349.1 ± 107.82	11	1850.9 ± 2441.79
Total	16	365.0 ± 108.44	16	1758.8 ± 2013.1
Control Group				
Male	8	377.5 ± 104.44	8	680.0 ± 298.57
Female	8	437.5 ± 100.53	8	440.0 ± 218.04
Total	16	407.5 ± 103.76	16	560.0 ± 281.33
Intervention Groups Total				
Male	31	367.7 ± 114.97	31	1413.5 ± 649.01
Female	36	371.4 ± 110.53	36	1349.4 ± 1544.16
Total	**67**	**369.7 ± 111.76**	**67**	**1379.1 ± 1207.05**

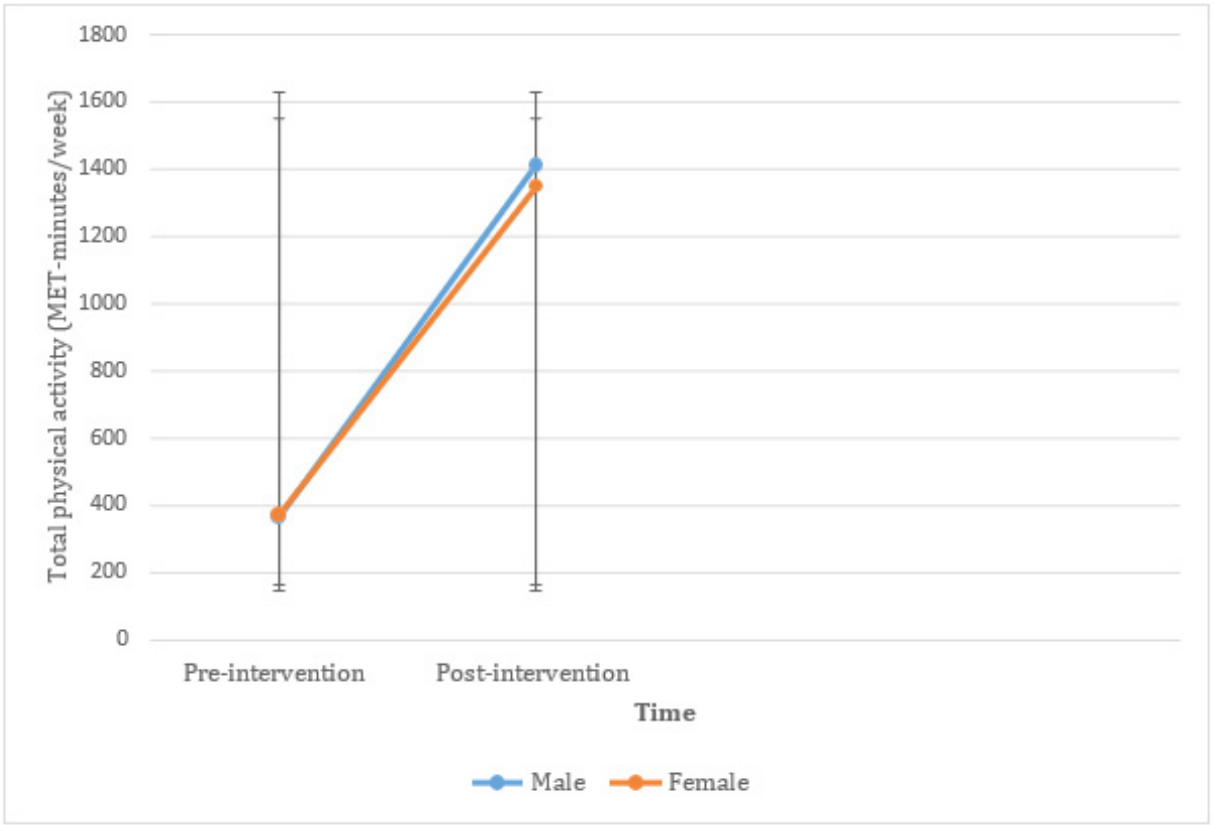

Figure 2: Total physical activity levels among PhD students according to gender.

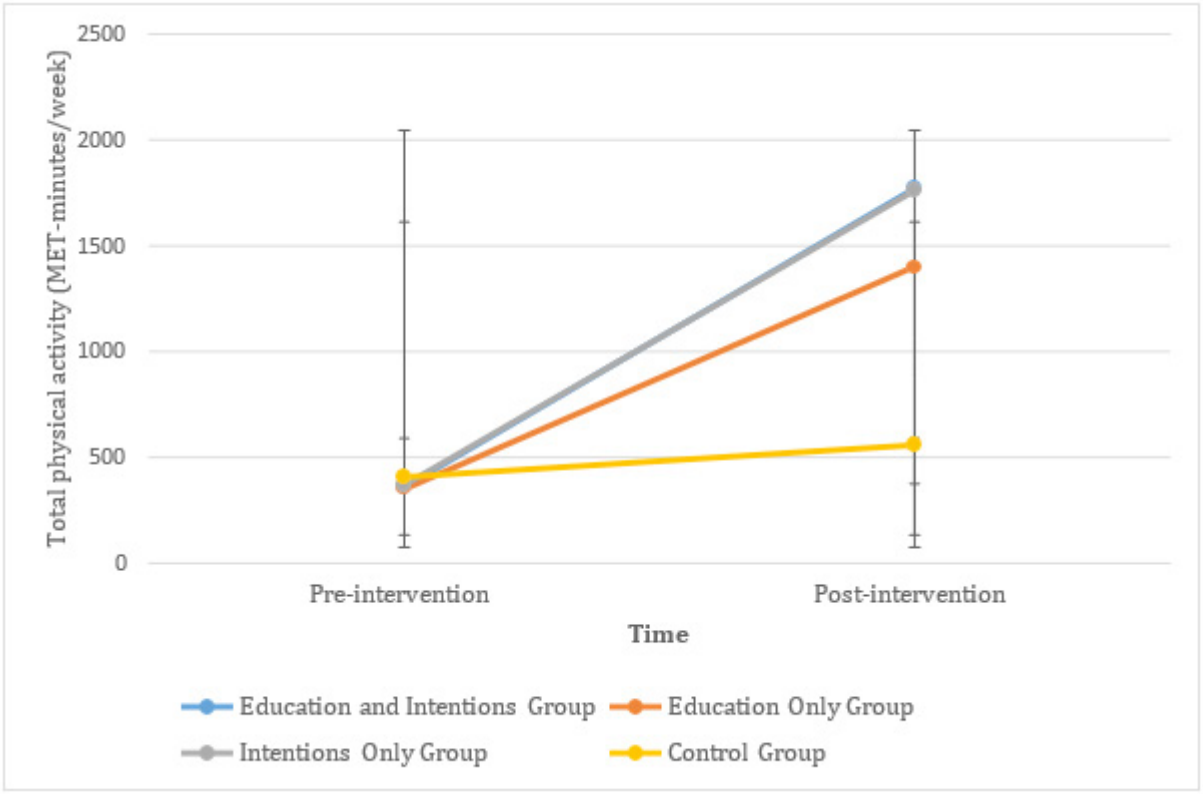

Figure 3: Total physical activity levels among PhD students according to intervention groups.

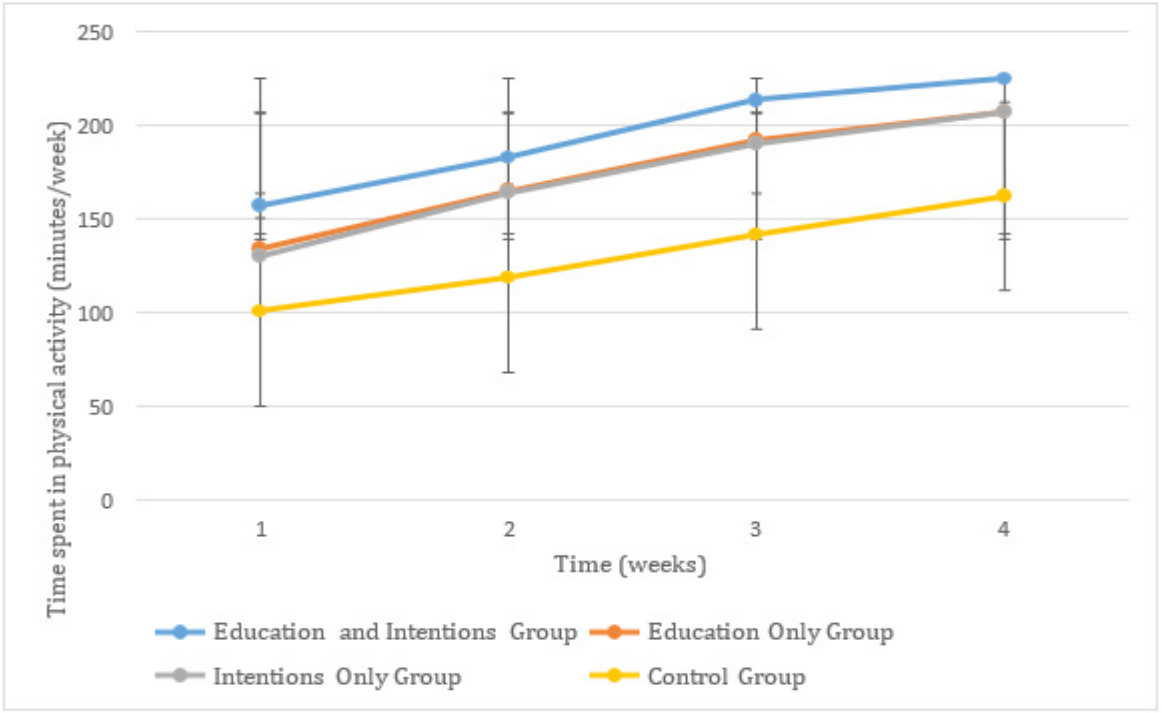

Figure 4: Time spent in physical activity weekly among PhD students according to treatment groups.

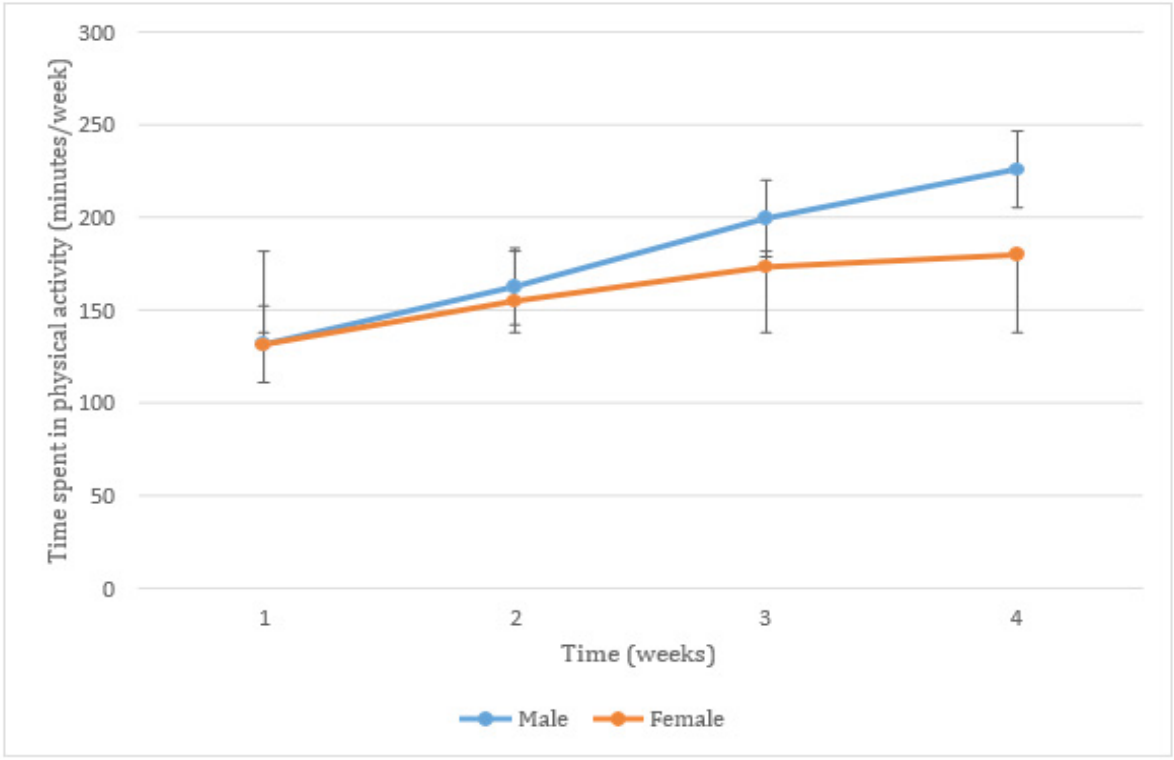

Figure 5: Time spent in weekly physical activity among PhD students according to gender.

There was a significant main effect of Time (F3,177 = 120.35, p<0.001, ηp2 =0.671), mean time spent in PA weekly of 132.0 ± 4.43 minutes/week at week 1, 159.3 ± 3.77 minutes/week at week 2, 186.3 ± 4.31 minutes/week at week 3 and 203.0 ± 4.49 minutes/week at week 4. There was a significant interaction between Time and Gender (F3,177 = 13.37, p<0.001, ηp^2 =0.185). Follow-up Bonferroni pairwise comparisons test indicated that there was a significant difference between education and intentions group and control group (p<0.001); between education only group and control group (p<0.001) and between intentions only group and control group (p<0.001), but there were no differences between the other groups (p>0.05). There was also a significant difference between male and female participants (p=0.03); between week 1 and week 2 (p<0.001); between week 1 and week 3 (p<0.001), between week 1 and week 4 (p<0.001), week 2 and 3 (p<0.001), between week 2 and week 4 (p<0.001) and between week 3 and week 4 (p<0.001).

This showed that although all four intervention groups increased in time, they spent in PA weekly from week 1 to week 4, the other three treatment groups generally performed better than the control group. The male participants also spent more time engaging in PA weekly compared to the female participants. Additionally, independent-samples t-tests results showed that there were no significant differences in Time Spent in PA weekly between male (mean=131.5 ± 31.71 minutes/week) and female (mean=131.0 ± 47.17 minutes/week) participants at week 1; t (65) = 0.048, p=0.96; and between male (mean= 162.6 ± 32.96 minutes/week) and female (mean=154.6 ± 43.48 minutes/week) participants at week 2; t (65) = 0.84, p=0.41. On the other hand, there were significant differences in Time Spent in PA weekly between male (mean= 199.2 ± 35.45 minutes/week) and female (mean=173.2 ± 50.51 minutes/week) participants at week 3; t (65) = 2.40, p=0.019; and between male (mean=225.6 ± 41.33 minutes/week) and female (mean=179.9 ± 42.52 minutes/week) participants at week 4; t (65) = 4.45, p=0.29. These results suggested that both male and female participants performed similarly in the time they spent in PA weekly up till week 3 and 4 where the male participants performed better that their female counterparts. The descriptive statistics showing the time PhD students spent in PA according to Intervention groups are presented in Table 3.

This is the first study, to our knowledge, that assessed psychological interventions to increase overall levels of PA as well as time spent in weekly PA among PhD students in a university setting using both motivational and volitional interventions underpinned by the Behavior Change Wheel (BCW), the Capability, Opportunity, Motivation-Behavior (COM-B) behavior model and the Theoretical Domains Framework (TDF) [3-4]. A major finding from this present study suggested that even though the participants in all the intervention groups increased in their total PA levels and time

spent in PA weekly, the greatest improvements occurred among the participants in the education and intentions group and intentions only group, who formed implementation intentions regarding time, days and places they would enact the planned PA, followed by the education only group, with the least occurring in the control group. The participants who received the educational and intentions packages through the 4-week intervention were more than twice likely to participate in PA compared to the participants in the control group.

Table 3: Descriptive statistics showing the mean time spent in physical activity weekly among PhD students.

Intervention Groups	N	Time spent in physical activity weekly (minutes/week) (mean (SD))			
		Week 1	Week 2	Week 3	Week 4
EIG					
Male	9	143.3 ± 29.58	170.0 ± 30.82	205.6 ± 32.83	238.9 ± 39.82
Female	8	172.5 ± 56.25	197.5 ± 50.36	222.5 ± 65.63	208.8 ± 59.63
Total	17	157.06 ± 45.24	182.9 ± 42.24	213.5 ± 49.99	224.7 ± 50.88
EG					
Male	9	128.9 ± 28.92	170.0 ± 26.93	214.4 ± 33.58	232.2 ± 28.19
Female	9	139.4 ± 21.86	160.0 ± 26.93	170.6 ± 24.55	182.8 ± 27.28
Total	18	134.2 ± 25.45	165.0 ± 26.62	192.5 ± 36.39	207.5± 37.03
IG					
Male	5	146.0 ± 24.08	184.0 ± 21.91	214.0 ± 23.02	248.0 ± 19.24
Female	11	123.6 ± 44.11	155.0 ± 22.69	179.5 ± 20.55	188.6 ± 24.91
Total	16	130.6 ± 39.58	164.1 ± 25.77	190.3 ± 26.36	207.2 ± 36.33
CG					
Male	8	111.9 ± 35.25	132.5 ± 31.05	165.6 ± 27.70	189.4 ± 47.39
Female	8	90.0 ± 23.90	105.0 ± 20.00	118.1 ± 29.02	135.6± 20.60
Total	16	100.9 ± 31.21	118.8 ± 28.95	141.9 ± 36.78	162.5 ± 44.91
Intervention Groups Total					
Male	31	131.5 ± 31.71	162.6 ± 32.96	199.2 ± 33.45	225.6 ± 41.33
Female	36	131.0 ± 47.17	154.6 ± 43.48	173.2 ± 50.51	179.9 ± 42.52
Total	**67**	**131.2 ± 40.46**	**158.3 ± 38.89**	**185.2 ± 45.77**	**201.0 ± 47.58**

Table Abbreviations: CG: Control group; EG: Education only group; EIG: Education and intervention group; IG: Intervention only group; SD: Standard deviation

This strengthens previous findings with regards to the mechanisms through which implementation intentions induce behavior. This aligns with previous studies [15,30,31] indicating that participants who had very good memory for the days, times and places detailed in their implementation intentions were more likely to enact the behavior as specified. In support of this findings, some other studies that have used implementation intentions either alone [18,21,32,33] or in combination with other interventions [19,20,23,30] to improve PA engagement have been generally very successful. This is also in line with the COM-B model and the TDF) which posits that intention is a strong prognosticator of behavior change. Strong evidence suggests that implementation intentions are an efficacious approach to support health-associated habits; however, mixed findings are seen as regards PA [34]. Even though a meta-analysis to examine the impact of implementation intentions on PA engagement indicated small to medium effect sizes [34], various studies [19,21,23] revealed that this approach was more effective amongst student, especially if supported with ways to prevent possible obstacles that may prevent achievement of planned PA.

Previous research [31,35,36] further suggests that implementation intentions reduce the likelihood of individuals not remembering to begin goal-focused behavior at the point of initiation. This is probably because implementation intentions produce an intensified accessibility of the cognitive representation of the indicated situational prompts (i.e., environmental cues) and stimulate direct (involuntary) control of the planned behavior via these prompts [15]. Therefore, it may be argued that goal intentions that have been complemented by implementation intentions concerning when and where an anticipated behavior will be enacted are more likely to be performed [16].

The results of this present study indicated of all the four levels of knowledge about PA, only level 2 knowledge (awareness of diseases associated with physical inactivity) and level 4 knowledge (knowledge of the increased risk of developing certain chronic

diseases due to not engaging in regular PA) showed a significant association with PA engagement. This supports the findings of Hui & Morrow [38], which indicated that individuals with limited awareness of diseases linked to physical inactivity were less likely to meet recommended PA levels. A recent study by Fredriksson, et al. [37] among Australian adults also showed that higher awareness of diseases associated with physical inactivity correlated with increased PA, reinforcing the findings of this study. Therefore, higher Level 2 knowledge is crucial in promoting the desired behavior, as understanding the harms of inactivity can drive positive behaviors towards being more active [37].

Additionally, participants in the education and intentions group performed better in Level 4 knowledge. They participated in more PA, followed by the intentions-only group, the education-only group, and lastly the control group. In contrast, Fredriksson, et al. [37] found no significant association between Level 4 knowledge and PA engagement, suggesting that participants who scored high on Level 4 knowledge might believe that physical inactivity increases their risk of developing chronic diseases, but if this risk is not perceived as serious, they might not have a strong rationale to be physically active. Therefore, it can be argued that participants in this study who scored high in Level 4 knowledge engaged more in PA because they perceived the risks of not engaging in regular PA to be very serious, with an increased risk of contracting chronic illnesses during their lifetime. The TDF posits that individuals with stronger beliefs about the consequences of a behavior are more likely to engage in health-promoting behaviors such as PA [14], thereby supporting the results of this study. Therefore, future studies aimed at increasing PA levels among inactive university students should consider integrating the increased risk of physical inactivity leading to chronic diseases into educational materials.

Finally, this present study demonstrated that gender had no significant effect on total physical PA levels among participants in the various intervention groups, both pre- and post-intervention. Although most studies in university settings have reported higher PA levels among male students compared to female students, a study by Wilson, et al. [39] among university students in the United States supported the findings of this study, revealing no significant gender difference in reported moderate PA. This may be because all participants in the present study were physically inactive, which could have influenced the findings. In contrast, this study also suggested that the male participants generally performed better than their female counterparts on time spent in PA weekly, especially from the third to the fourth week of intervention. This may be because male participants began engaging in more vigorous PA from the third week of the intervention compared to female participants.

These findings align with previous research conducted among students in various universities worldwide [40-43], which also reported higher PA participation among male students compared to their female peers. Additionally, Hickey & Mason [44] found that male students in an American university engaged in more hours and types of PA compared to female students, consistent with the findings of this study. This may be because females often perceive fewer motives and more obstacles to participating in PA compared to males [45]. Even though female participants generally spent less time in PA weekly than male participants, as suggested by this study, some may have engaged in more intense PA due to the intervention effect, potentially counterbalancing the conventional notion that males are generally more physically active than their female counterparts. Another reason for these inconsistent findings may be due to the overestimation [46,47] or underestimation [48,49] of PA commonly associated with self-report measures, which were used in this study. Therefore, further studies could assess the effect of gender on PA and time spent in PA weekly among a broader student population using objective measures.

Conclusion

This study provides new insight into the efficacy of a theory-based brief intervention aimed at improving the university PhD students' knowledge and intentions to engage in PA. The findings demonstrated that the intention to engage in PA is key, as both education and intentions group and intentions only group performed better than the control group. Therefore, if there is improved education/knowledge, as well as better intentions then the outcome of pro-physical activity behavior is stronger, which is more likely to result in action to be taken. Furthermore, gender had no influence on the PA levels of the PhD students but influenced the time spent engaging in PA weekly. Therefore, brief interventions with focus on improved education/knowledge, as well as intentions, can be used as a university-wide approach to increase PA engagement among students, as a way of improving their overall wellbeing. Furthermore, in designing future interventions to increase PA engagement amongst university students, it is also imperative to consider the influence of gender differences.

Acknowledgement

This study is part of a series of investigations conducted during my PhD. I would like to express my gratitude to the Department of Psychology at the University of Derby for their support with data analysis.

Conflict of Interest

The authors declare that there are no conflicts of interest regarding the publication of this manuscript. All authors have approved the final version of the manuscript and agree with its submission. The research was conducted independently, and no external funding or influence affected the study's design, data collection, analysis, or interpretation.