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Relationships between mental toughness, barriers to exercise, and exercise behaviour in undergraduate students

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Publication Details

Stamp, E., Crust, L., Swann, C. & Perry, J. (2017). Relationships between mental toughness, barriers to exercise, and exercise behaviour in undergraduate students. *International Journal of Sport Psychology*, 48 (3), 262-277.

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Abstract

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Keywords

exercise, students, between, undergraduate, relationships, behaviour, exercise, barriers, toughness, mental

Disciplines

Education | Social and Behavioral Sciences

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1 Running head: Mental Toughness and Barriers to Exercise

2 Title: Relationships between mental toughness, barriers to exercise, and exercise behaviour in
3 undergraduate students

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12 **IJSP Special Issue**

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Abstract

The present study explored relationships between mental toughness (MT), barriers to exercise, and self-reported exercise behaviour in university students. Perceived barriers to exercise are important since previous work has identified barriers as strong predictors of exercise behaviour. MT was hypothesised to predict exercise barriers and self-reported exercise behaviour. Participants were 173 undergraduate students (45 men, 128 women) from 10 United Kingdom universities. Questionnaires were used to assess MT, exercise levels, and exercise barriers. Path analysis identified that MT predicted barriers to exercise, with higher MT associated with weaker perceived barriers. Regular exercisers were found to have significantly higher MT than non-regular exercisers, with commitment identified as a key difference. These findings support the proposed hypotheses and provide further evidence of the importance of MT in exercise / physical activity contexts. Future research that adopts longitudinal designs and tests targeted interventions to reduce perceptions of barriers and enhance exercise participation are encouraged.

Keywords: Exercise, exercise barriers, higher education, individual differences, physical activity.

1.0 Introduction

Inactive lifestyle is one of the most serious threats to public health in the United Kingdom (UK) and across the western world (Lee et al., 2012; Townsend, Wickramasinghe, Williams, Bhatnagar & Rayner, 2015). Physical inactivity has been consistently associated with higher levels of obesity and increased risk of developing preventable chronic illnesses such as cardiovascular disease, diabetes, and osteoporosis (Lee et al., 2012). Despite the known physiological (e.g., cardiovascular, respiratory function) and psychological (e.g., wellbeing, mood) benefits of regular and frequent physical activity (PA) / exercise¹, it is evident that knowledge alone is not enough to facilitate the adoption and maintenance of active lifestyles (Buckworth, Dishman, O’Conner & Tomporowski, 2013). PA behaviour change and maintenance has proven complex and challenging and is influenced by numerous psychosocial, economic, environmental, and personal factors. For example, levels of PA in the UK and elsewhere have generally been found to decline when young people attend university (Bray & Born, 2004; Daskapan, Tuzun & Eker, 2006; Lovell, Ansari & Parker, 2010). Time at university signifies an important transition period into adulthood that represents an opportunity to influence PA behaviours (Lovell et al., 2010). One study found almost a quarter of students gained significant weight during the first semester of study (Wengreen & Moncur, 2009). This trend is concerning given that habits formed during early adulthood may impact upon life-long PA behaviour, with evidence that patterns of PA can remain relatively stable up to five years post-graduation (Sparling & Snow, 2002).

Numerous theoretical approaches have been developed and applied to understand health behaviours in general and PA in particular. One important framework is the Health Belief Model (HBM). The HBM predicts that the likelihood of engaging in preventative health behaviours such as PA is a function of the perceived threat (inactivity in this case) and

¹ While the term ‘exercise’ is used throughout, we situate this within the broader conceptualisation of physical activity as a lifestyle behaviour of which exercise is a subcomponent.

1 the relative costs (e.g., barriers, difficulties, hindrances), as opposed to benefits of adopting a
2 new behaviour. Despite this prediction, evidence has identified a greater number of perceived
3 PA barriers to be associated with lower levels of PA (Ross & Melzer, 2015). Much research
4 has focused upon identifying the correlates of PA and, in particular, understanding the
5 perceived barriers that predict low adoption and dropout, as an important prerequisite for
6 designing and implementing interventions for change (Buckworth et al., 2013). Although it is
7 not the aim of the current paper to test or extend models of behaviour, awareness of such
8 models is important for exploring an individual's behaviour.

9 Sechrist, Walker and Pender (1987) presented four main categories of exercise
10 barriers: (1) exercise milieu, which concerns the environment limiting participation (e.g.,
11 access to facilities, being embarrassed to exercise into front of others), (2) physical exertion,
12 referring to the pain and discomfort of exercise deterring the individual from PA, (3) time
13 expenditure, which concerns the amount of time exercise takes from other commitments, and
14 (4) family discouragement, which reflects family members inhibiting exercise participation.
15 Research concerning university students found that barriers such as lack of family support
16 and unpleasantness of exertion (Daskapan et al., 2006; Lovell et al., 2010) are of high
17 theoretical importance with influence dependent on demographics such as age, gender, and
18 ethnicity. It is apparent that in PA / exercise settings most reported barriers are perceived
19 rather than real (thus within personal control), and are indicative of priorities. It is therefore
20 likely that individuals who have high control over their lives perceive fewer barriers to
21 exercise.

22 Certain psychological traits (e.g., extroversion, neuroticism) have been found to
23 predict PA / exercise behaviour. A meta-analysis (Rhodes & Smith, 2006) that included 33
24 studies examining a range of personality traits found extraversion (i.e., tendency to be lively,
25 energetic, sociable, seek excitement and experience positive affect) and conscientiousness

1 (i.e., tendency to be organised, self-disciplined, and goal-oriented) to be significantly and
2 positively related to PA ($r = .23$, 95% credibility interval of $r = .08, .38$; $r = .20$, 95%
3 credibility interval of $r = .06, .34$ respectively). In contrast neuroticism (i.e., tendency to be
4 emotionally unstable and anxious) was found to be a significant negative predictor of PA
5 behaviour. When controlling for demographic factors, these reported relationships were
6 found to explain a small but significant proportion of variance. In addition, two other
7 important psychological variables (self-efficacy and self-motivation) have been found to be
8 among the best predictors of PA behaviours, especially in the long-term pursuit of
9 behavioural goals (Buckworth et al., 2013). As such, individual differences in key
10 psychological variables have been found to be important in adopting and maintaining PA /
11 exercise in light of numerous potential barriers that may need to be circumnavigated.

12 Mental toughness (MT) is defined as a collection of experientially developed and
13 inherent values, attitudes, emotions, and cognitions that influence the way in which an
14 individual approaches, responds to, and appraises both negatively and positively construed
15 pressure, challenge, and adversity to consistently achieve his or her goals (Gucciardi, Gordon
16 & Dimmock, 2009). It is generally agreed MT is a multi-dimensional construct which
17 influences an individual's interpretation of a situation, and an important resistance resource
18 linked to successful coping in adverse or stressful conditions (Nicholls, Levy, Polman &
19 Crust, 2011). Although appearing similar to other psychological variables (e.g., hardiness,
20 resilience) MT is a distinct construct. For example, whereas a hardy individual copes with
21 challenges which are encountered, a mentally tough individual will seek challenges and even
22 thrive off competition (Strycharczyk & Clough, 2015). Furthermore, hardiness does not
23 consider the role of confidence which is consistently recognised as a key component of MT
24 (e.g. Jones et al., 2002). Differences also exist between MT and resilience. Resilience refers
25 to coping during negatively construed situations and bouncing back, whereas MT

1 incorporates the effect of positively construed situations and thriving on the pressure and
2 challenge (Gucciardi, Gordon & Dimmock, 2008). Clough, Earle, and Sewell (2002)
3 proposed that MT is represented by: (1) control (emotional and life), which reflects a
4 tendency to feel and act as if one is influential, (2) commitment, which concerns deep
5 involvement with whatever one is doing, in contrast to alienation, (3) challenge, refers to the
6 extent to which individuals see problems as opportunities for self-development rather than
7 threats, and (4) confidence (in abilities and interpersonal), reflecting a high sense of self
8 belief and an unshakeable faith in having the ability to achieve success while not being
9 intimidated when dealing with other people. More recently Clough and Strycharzyck (2012)
10 have described MT as trait-like after behavioral genetic research found MT, like most traits,
11 was influenced by a combination of inherited (95% CI of parameter estimates = .30, .62) and
12 non-shared environmental factors (95% CI of parameter estimates = .38, .61; Horsburgh,
13 Schermer, Veselka, & Vernon, 2009). In addition, Horsburgh et al. also found MT to be
14 significantly correlated with all components of the common five factor taxonomy of
15 personality (i.e., extraversion, conscientiousness, openness to experience, agreeableness and
16 neuroticism; 95% CI of parameter estimates = .35, .68; .16, .60; .07, .43; .17, .58; -.77, -1.00
17 respectively). Subsequent work has supported the enduring properties, as well the variable
18 nature of MT (Gucciardi, Hanton, Gordon, Mallet & Temby, 2015).

19 The importance of MT has been demonstrated in a plethora of applied settings such as
20 business, health, and education (Clough & Strycharzyck, 2012). In higher education, MT was
21 recently found to predict academic achievement and progression in 161 first year students;
22 while those with lower MT were more likely to withdraw from their programme (Crust, et al.,
23 2014). In addition, MT was found to predict psychological wellbeing across all levels of
24 undergraduate study (Stamp, et al., 2015). Thus MT appears to facilitate coping with the
25 challenges associated with transition and also the ongoing demands of higher education.

1 Other work has begun to examine the relationship between MT and PA behaviours
2 given that MT is a multidimensional construct that incorporates aspects such as commitment,
3 self-confidence, and life control, which are likely important to adopting and maintaining
4 target behaviours. Gerber et al. (2012) examined relationships between self-reported PA and
5 MT in 284 high school students ($M = 18$ years). Higher levels of PA and exercise were
6 significantly and positively related to overall MT and the subscales of life control,
7 commitment and challenge, with those who met current PA guidelines reporting significantly
8 higher MT than those who did not.

9 Using qualitative interviews with exercisers and exercise leaders, Crust, Swann,
10 Allen-Collinson, Breckon and Weinberg (2014) sought to understand MT in exercise settings.
11 Participants appeared to perceive fewer barriers to exercise; while injury, lack of energy, and
12 time constraints were reported, participants made sacrifices and were adaptable to ensure
13 exercise goals were achieved. It appears likely that exercisers with high or low MT
14 experience similar potential barriers to exercise, but those higher in MT have somewhat
15 different perceptions (i.e., challenge rather than threat) and appear more adept at coping with
16 life demands to ensure enough time to remain physically active. This finding is consistent
17 with research concerning MT and coping that has found tougher individuals employ more
18 problem-focused coping strategies and less avoidance coping (Nicholls, Polman, Levy &
19 Backhouse, 2008), and were more effective at coping with stressors remaining relatively
20 unaffected (Gerber et al., 2013; Nicholls et al., 2011).

21 The present study examined relationships between MT and perceived barriers to
22 exercise in undergraduate university students. We hypothesised that students with lower MT
23 would perceive stronger barriers to PA. This population was chosen because the transition
24 from further to higher education is characterised by ambiguity and changing academic, social
25 and emotional demands that require psychological adjustment (Macaskill, 2013; Wynaden,

1 Wichmann & Murray, 2013). There is evidence that levels of moderate and vigorous PA drop
2 significantly following transitions to college or University as other life stressors (i.e.,
3 independent living, assignment work, examinations etc.) impinge on lifestyle habits (Bray &
4 Born, 2004; Han, et al., 2008). It is likely that individual differences account for some of this
5 variance, in particular students with higher MT are predicted to perceive their environment
6 and encountered situations as less threatening, thus perceiving fewer barriers to overcome.
7 When barriers are encountered students with higher MT are predicted to be better able to
8 cope with the challenges of higher education and thus maintain pre-university lifestyles (e.g.,
9 PA). The main aim of the present study is to extend existing work on the relationship
10 between MT and PA by examining self-reported levels of exercise in university students, and
11 to evaluate perceived barriers to exercise within this population. Examining these
12 relationships could be important in regards to identifying students at risk of adopting more
13 inactive lifestyles and subsequently developing targeted interventions to attenuate the risks
14 (e.g., change perceptions of barriers).

15 **2.0 Method**

16 **2.1 Participants**

17 Participants were 173 undergraduate university students (45 males, 128 females) from
18 a range of undergraduate courses across 10 UK institutions. Participants' ages ranged
19 between 18 – 40 years ($M = 20.86$, $SD = 3.39$). The majority of the sample was White
20 British; approximately 5% were other ethnicities including Sri Lankan, Zimbabwean, and
21 French. The sample was representative of students from a wide range of courses including
22 Zoology, Fashion and Design, and Sport and Exercise Science. The sample consisted of 63
23 first years, 45 second years, and 65 third years, with 76% of the sample moving away from
24 the family home to attend university.

25 **2.2 Instruments**

1 **2.2.1 Self-reported PA.** Initially the International Physical Activity Questionnaire
2 (IPAQ; Craig et al., 2003) was used to record self-reported PA but following reliability issues
3 one of the demographic questions, which asked participants if they partook in regular
4 exercise at least three times a week, was used as an alternative measure. This presented as a
5 dichotomous variable that indicated whether or not participants met pre-specified criteria.
6 Thus, in the present study a regular exerciser was defined as an individual who exercises for
7 30 minutes or more at a moderate to vigorous intensity to maintain or improve health / fitness
8 at least three times a week.

9 **2.2.2 Exercise barriers.** The exercise barriers scale from the Exercise Benefits and
10 Barriers Scale (EBBS; Sechrist et al., 1987) was used to assess participants' barriers to
11 exercise and took less than five minutes to complete. Although this is an older measure of
12 exercise barriers, contemporary research has demonstrated the barriers appear relevant to
13 current students. For example, pain of exercise (Lovell et al., 2010), family influences
14 (Daskapan et al., 2006), lack of time (Gomez-Lopez, Gallegos & Extremera, 2010), and
15 environmental factors such as lack of resources (Kulavic, Hultquist & McLester, 2013) have
16 recently been reported to inhibit exercise participation. Furthermore, the EBBS has been used
17 in recent research (e.g., Cantell, Wilson, Dewey, 2014; Stroud, Minahna, Sabapathy, 2009).
18 Participants rated the 14 items that describe potential barriers to exercise on a 4-point Likert
19 scale ranging from (1) strongly agree to (4) strongly disagree. The instrument provides an
20 overall score as well as four individual component scores which represents the strength of
21 each barrier (i.e., exercise milieu, physical exertion, time expenditure, family
22 discouragement). Higher scores represented a weaker barrier to exercise. The barriers scale
23 was previously reported to have good internal consistency, construct validity (Brown, 2005),
24 and test – re-test reliability (Sechrist et al., 1987).

1 **2.2.3 Mental toughness.** The Mental Toughness Questionnaire (MTQ48; Clough et
2 al., 2002) was used to assess MT and took approximately 10 minutes to complete. This
3 questionnaire consists of 48 items which participants rated on a 5-point Likert scale; ranging
4 from (1) strongly disagree to (5) strongly agree. The instrument provides an overall MT score
5 and a score for the six subscales (i.e. challenge, commitment, life control, emotional control,
6 confidence in abilities, interpersonal confidence) with higher scores representing greater MT.
7 Some acrimonious debate has ensued about measuring MT, and in particular the
8 appropriateness of using the MTQ48 and the underpinning 4C's model (Clough, Earle, Perry,
9 & Crust, 2012; Gucciardi, Hanton, & Mallett, 2012). While Gucciardi et al. report strong
10 concerns and have called for use of the MTQ48 to cease, others have highlighted problems
11 associated with applying an overly rigid assessment of model fit with multi-dimensional
12 measures (Hopwood & Donnellan, 2010; Perry, Nicholls, Clough, & Crust, 2015). The
13 MTQ48 has generally been reported to have good criterion, content, and construct validity
14 (Clough et al., 2002); other studies have supported the reported factor structure (Horsburgh et
15 al., 2009) and one large-scale psychometric analysis found broadly adequate psychometric
16 properties (Perry, Clough, Crust, Earle & Nicholls, 2013). However, the reliability of the
17 emotional control subscale has been identified as problematic (Perry et al., 2013).
18 Nevertheless, emotional control is theoretically an important component of MT which should
19 be retained within the model, thus Perry et al. (2013) recommended continuing to use the
20 scale with caution, potentially removing two problem items to achieve better fit indices.

21 **2.3 Procedure**

22 Following ethical approval from a university research ethics committee, six academic
23 staff known to the research team were contacted via e-mail and asked to disseminate to
24 students, a link to the online questionnaire. The link contained an advertisement for students
25 to participate in a study exploring psychological characteristics and lifestyle choices. A broad

1 description of the study was forwarded to avoid a biased sample, for example being more
2 appealing to students who regularly exercise, and reduce socially desirable responses. Given
3 the relatively equal split of regular exercisers (57%) and non-regular exercisers (43%), it
4 appeared as though the sample was not overtly biased towards exercisers. Staff were from a
5 range of departments and institutes, resulting in students from 10 universities being
6 represented in the current study. The self-paced questionnaire consisted of demographic
7 questions, as well as standardised questionnaires previously described, and took
8 approximately 20 minutes to complete. The order the questions were administered were: (1)
9 demographic questions (age, ethnicity, changes in PA since attending university), (2)
10 MTQ48, (3) IPAQ, and (4) EBBS. Data collection occurred half way through the academic
11 year. Following completion of the questionnaire an online written debrief was provided.

12 **2.4 Data Analysis**

13 Data was initially screened for outliers and missing variables. Mean, standard
14 deviation, skewness and kurtosis of variables were calculated prior to proceeding with further
15 statistical analysis. Omega point estimates and confidence intervals were used to assess the
16 internal consistency of the questionnaires, as omega holds fewer assumptions about the scale
17 and sampling than alpha (Dunn, Baguley, & Brunnsden, 2013). Regular and non-regular
18 exercisers' MT and exercise barriers were compared using independent *t*-tests with 5,000
19 bootstraps to generate confidence intervals. Pearson correlations explored the relationships
20 between MT and exercise barriers. A path analysis model was examined posited MT
21 components as predictor variables of exercise barriers whilst controlling for age, gender, and
22 year of study.

23

24

3.0 Results

1 No missing data was evident. Tests of univariate normality found all data were within
2 standard limits of kurtosis and skewness (< 2). Descriptive statistics are displayed in Table 1.
3 We calculated Omega point estimates and confidence intervals using the MBESS package
4 (Kelley & Lai, 2012), in R (R Development Core Team, 2012), with 1,000 bootstrap samples.

5 Subscales of MT had good internal consistency (i.e., $> .70$) with the exception of
6 emotional control (.49 [95% CI = .28, .60]) and life control (.69 [95% CI = .57, .78]). Life
7 control internal consistency was deemed to be at the lower end of acceptability. Inter-item
8 correlation matrix was examined to identify troublesome items of emotional control.
9 Negative correlations were identified between items 26 and 34, which is in line with previous
10 research (Perry et al., 2013) resulting in the removal of these items. This resulted in the five
11 remaining components presenting omega of .60 (95% CI = .44, .66). The remaining items
12 were used as a measure of emotional control in all proceeding analyses. All exercise barrier
13 scales presented good internal consistency, with the exception of family discouragement (.56,
14 95% CI = .40, .70). This is to be expected, as this subscale only includes two items. These
15 items were reasonably well correlated (.39, 95% CI = .23, .55).

16 Regular exercisers' overall MT ($M = 3.43$, $SD = .41$) was significantly higher than
17 non-regular exercisers' MT ($M = 3.26$, $SD = .55$, $p < .05$, $d = .35$). The regular exercisers
18 reported significantly weaker overall barriers to exercise ($M = 3.21$, $SD = .48$) than non-
19 regular exercisers ($M = 2.68$, $SD = .45$, $p < .001$, $d = 1.14$). Differences in overall MT and
20 individual barriers to exercise between regular and non-regular exercisers are presented in
21 Table 2. Although there are statistically significant differences in MT, it should be noticed
22 that these are small effects. Thirty percent of the sample reported a reduction in exercise
23 levels after starting university.

24 The relationships between MT components and exercise barriers were explored using
25 Pearson's bivariate correlations with 95% confidence intervals achieved from 5,000

1 bootstrapped samples (Table 1). Overall MT was significantly correlated with overall barriers
2 to exercise ($r = .35$, 95% CI = .19, .50, $p < .01$). The strongest relationships existed between
3 exercise milieu and life control ($r = .38$, 95% CI = .22, .52, $p < .01$), and exercise milieu and
4 confidence in abilities ($r = .36$, 95% CI = .20, .49, $p < .01$) which displayed a moderate
5 relationship.

6 To determine the extent to which MT variables were predictive of exercise barriers,
7 we examined a path model using Mplus 7 (Muthén & Muthén, 2012). We employed the
8 maximum likelihood estimator and obtained confidence intervals by running 5,000
9 bootstrapped samples. Age, gender, and year of study were inserted as moderating variables.
10 The results (Table 3) indicated that emotional control negatively predicted exercise milieu (β
11 = $-.22$, 95% CI = $-.45$, $.02$, $p < .05$) and time expenditure ($\beta = -.24$, 95% CI = $-.51$, $.04$, $p <$
12 $.05$). In contrast confidence in abilities positively predicted the same two exercise barriers
13 (exercise milieu: $\beta = .27$, 95% CI = $-.05$, $.53$, $p < .05$; time expenditure: $\beta = .41$, 95% CI = $.07$,
14 $.72$, $p < .01$). Physical exertion was positively predicted by commitment ($\beta = .20$, 95% CI = $-.08$,
15 $.46$, $p < .05$) and there was a non-significant trend to suggest a positive association for
16 physical exertion on confidence in abilities ($\beta = .21$, 95% CI = $-.10$, $.51$, $p = .06$). Family
17 discouragement was not predicted by any components of MT.

18 4.0 Discussion

19 The main aim of the present study was to evaluate relationships between MT,
20 perceived barriers to exercise, and self-reported exercise behaviour, across a broad range of
21 undergraduate students. Several important findings emerged. First, in support of the main
22 hypothesis, MT was found to be significantly and positively related to the strength of
23 perceived barriers to exercise ($r = .35$, $p < .01$). That is, participants with lower MT perceived
24 barriers to exercise to be stronger thus more of an obstacle to overcome, or deterrent to
25 exercise. This finding is consistent with previous research that has shown MT to be related to

1 different perceptions during challenging situations (Clough et al., 2002; Levy et al., 2006)
2 and greater optimism (Nicholls et al., 2008). Theoretically this result is important given the
3 role of perceived barriers in predicting actual behaviour in the HBM. The present evidence
4 highlights that individual differences such as MT are important in determining how barriers
5 are perceived, and in turn influence actual behaviour. In terms of barriers, although all
6 barriers were significantly related to MT, exercise milieu (environmental factors) was found
7 to have the strongest relationship. Commitment and control have previously been
8 significantly and positively correlated with meeting PA guidelines (Gerber et al., 2012),
9 which is consistent with the current study that found commitment to be a key distinguishing
10 factor between regular and non-regular exercisers.

11 Commitment emerged as a key component of MT in the present study and was found
12 to be the strongest predictor of the physical exertion barrier. This is consistent with Crust et
13 al. (2014) who reported mentally tough exercisers were highly committed, exhibited high
14 volumes and intensity of training, enjoyed punishing training schedules, and associated
15 exercise pain positively as an indication of working hard. Crust et al. also found mentally
16 tough exercisers prioritised exercise, organised their time effectively and made sacrifices to
17 ensure exercise goals were achieved. Previous research also identified commitment to be
18 significantly and positively correlated with pain-tolerance, and negatively associated with
19 pain catastrophising during sports rehabilitation (Levy et al., 2006). Commitment is
20 significantly related to conscientiousness which in turn has been found to be a significant
21 predictor of PA (Rhodes & Smith, 2006).

22 Confidence in abilities was the strongest predictor of exercise milieu and time
23 expenditure barriers. This is congruent with previous findings that confidence in abilities is
24 related to planning and logical analysis, which enables the individual to transform perceived
25 unmanageable events to appear manageable (Nicholls et al., 2008). Despite family

1 discouragement being significantly related to MT there were no individual MT components
2 which were significant predictors, however this was found to be the weakest barrier to
3 exercise.

4 Consistent with the findings for MT and exercise barriers, students who participated
5 in regular exercise reported significantly higher MT than those who did not. This result with
6 university students supports previous work that found differences in MT between high school
7 students who reported no days, as opposed to three or more days of vigorous PA per week
8 (Gerber et al., 2012). While Gerber et al. (2012) highlighted differences in coping as one
9 potential explanation, and the possibility that involvement within PA contexts could develop
10 MT, present findings indicate the importance of perceptions. The role of commitment was
11 also reinforced as the factor most clearly differentiating between regular and non-regular
12 exercisers.

13 As expected, regular exercisers reported significantly weaker barriers to exercise than
14 non-regular exercisers, which shows perceived barriers to exercise is related to actual
15 exercise behaviour. This finding is consistent with the HBM which proposes the associated
16 costs of behaviour (i.e., barriers to exercise) are related to actual behaviour (i.e., exercise).
17 The strongest barrier found amongst the current sample was physical exertion (hard work,
18 associated fatigue) which is consistent with a previous study of non-exercising female UK
19 university students (Lovell et al., 2010). Similar to previous work (Bray & Born, 2004)
20 current findings identified 30% of students reported decreased exercise behaviour since
21 starting university. It would appear that some students are better able to adjust to the
22 upheavals and challenges of University life. The decline in exercise levels amongst some
23 university students highlights the importance of personal resources in overcoming perceived
24 exercise barriers.

1 The current findings demonstrate the importance of MT as a predictor of exercise / PA,
2 and provide further evidence that individual differences are part of a complex range of factors
3 that determine exercise / PA behaviours (Rhodes & Smith, 2006). High levels of MT are
4 associated with effective time management, maintaining several commitments at once, doing
5 things which an individual does not want to, working hard, having a sense of purpose, being
6 less influenced by others, perceiving to have control and self-selecting behaviours as opposed
7 to ‘drifting’ through life (Clough & Strycharzyck, 2012). Furthermore, mentally tough
8 individuals directly address problems (Nicholls et al., 2008) and effectively cope with
9 stressors (Gerber et al., 2013). Thus these individuals may be more effective at adapting to
10 the challenging environment of higher education and circumnavigating perceived barriers to
11 exercise. In contrast, individuals with lower MT tend to adopt more avoidance coping
12 strategies (Nicholls et al., 2011), and view obstacles as threats to be avoided. This may
13 explain why these individuals perceive stronger barriers to exercise.

14 One strength of the current study was the inclusion of participants from all three
15 undergraduate years, from a range of subjects, and from across several institutions.
16 Furthermore, adopting a multidimensional approach to measuring MT enabled the effect of
17 individual components to be identified which may help future researchers to develop and test
18 targeted interventions. Given that present findings identified differences in perceived rather
19 than actual barriers, future researchers may wish to examine the effects of interventions to
20 change perceptions. Similar approaches to those adopted in sport psychology that have shown
21 performance benefits from training participants to perceive anxiety as more facilitative
22 (Hanton & Jones, 1999), may be useful in exercise / PA settings (e.g. learning to perceive
23 exercise fatigue as indication of a beneficial workout). Given present findings, university
24 students with lower MT and those who perceive greater barriers to exercise may benefit from
25 targeted interventions to develop confidence and commitment; two components of MT seen

1 as crucial in regards to achieving exercise goals (Crust et al., 2014). For example, setting
2 goals to enhance commitment to achieve a weekly exercise target (Clough & Strycharzyck,
3 2012).

4 Limitations of the present study include the possibility of socially desirable responding, a
5 concern associated with all types of questionnaires. Online data collection is difficult to
6 control in terms of potential influences on respondents (e.g. others being present).
7 Furthermore, only a small percentage of students contacted (around 10%) actually completed
8 the questionnaire with the majority being female respondents, however, gender was not found
9 to be a significant predictor in the current study. The present study employed a self-report
10 measure of exercise whereas to gain more precise measures future researchers should
11 consider measuring actual PA via methods such as accelerometry. Furthermore, the use of a
12 cross-sectional design provides a snapshot analysis of the relationships between MT, exercise
13 barriers and exercise behaviour, while future work should consider longitudinal designs, to
14 examine behaviours long-term or assess the effectiveness of targeted interventions or
15 environmental manipulation on PA. In addition to modifying an individual's MT, institutions
16 could make changes to reduce perceived barriers. For example, by promoting convenient
17 times and locations of low cost exercise sessions, or providing sessions which are lower
18 intensity and allow beginners to develop confidence and achieve goals.

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1 Table 1

2 *Descriptive statistics, normality estimates, internal consistency coefficients, and bivariate correlations*

Variable	M ± SD	Skew	Kurt	1	2	3	4	5	6	7	8	9	10	11	12
Overall MT (1)	3.36 ± .48	-.70	1.29	(.92 [.90, .94])											
Challenge (2)	3.54 ± .55	-.51	.55	.77** [.70, .83]	(.70 [.61, .77])										
Commitment (3)	3.49 ± .58	-.51	.55	.79** [.71, .85]	.55** [.42, .66]	(.81 [.75, .85])									
Emotional control (4)	2.86 ± .69	-.06	-.33	.73** [.65, .80]	.60** [.50, .69]	.42** [.26, .55]	(.60 [.44, .66])								
Life control (5)	3.45 ± .56	-.77	1.67	.80** [.72, .86]	.48** [.33, .62]	.63** [.52, .72]	.46** [.32, .57]	(.69 [.57, .78])							
Confidence in abilities (6)	3.14 ± .69	-.42	.04	.85** [.81, .89]	.55** [.42, .65]	.56** [.42, .67]	.63** [.53, .72]	.69** [.59, .77]	(.84 [.79, .87])						
Interpersonal confidence (7)	3.50 ± .75	-.45	-.06	.60** [.49, .69]	.39** [.25, .51]	.29** [.11, .45]	.38** [.24, .50]	.37** [.21, .52]	.39** [.25, .52]	(.78 [.71, .83])					
Total barriers (8)	2.98 ± .54	-.05	-.52	.35** [.19, .50]	.21** [.03, .38]	.29** [.12, .44]	.18* [.02, .33]	.36** [.20, .49]	.38* [.23, .51]	.15* [-.01, .30]	(.87 [.83, .89])				
Exercise milieu (9)	3.06 ± .62	-.22	-.42	.35** [.17, .50]	.21** [.01, .39]	.30** [.13, .45]	.16* [-.01, .31]	.38** [.22, .52]	.36** [.20, .49]	.15 [-.02, .30]	.89** [.86, .92]	(.79 [.73, .83])			
Physical exertion	2.48 ±	.17	-.36	.25**	.19*	.26**	.18*	.19*	.25**	.04	.66**	.43**	(.78		

(10)	.76			[.09, .39]	[.03, .33]	[.11, .41]	[.03, .33]	[.03, .33]	[.09, .40]	[-.14, .21]	[.57, .75]	[.28, .56]	[.71, .83]		
Time expenditure (11)	3.14 ± .75	-.95	.67	.20**	.09	.09	.07	.21**	.28**	.13	.79**	.61**	.30**	(.83	
				[.05, .34]	[-.05, .23]	[-.07, .24]	[-.09, .23]	[.04, .37]	[.13, .41]	[-.04, .28]	[.73, .85]	[.52, .70]	[.15, .44]	[.75, .87]	
Family discouragement (12)	3.25 ± .68	-.49	-.52	.23**	.13	.17*	.14	.25**	.23**	.14	.65**	.44**	.30**	.54**	(.56
				[.09, .36]	[-.01, .28]	[.03, .30]	[-.01, .27]	[.10, .39]	[.09, .37]	[-.02, .29]	[.55, .75]	[.31, .57]	[.15, .44]	[.38, .67]	[.40, .70]

1 *Note.* 95% Bootstrapped confidence intervals presented in brackets. Internal consistency coefficients presented along the diagonal in
 2 parentheses. * Statistically significant at $p < 0.05$; **Statistically significant at $p < 0.01$.

1 Table 2

2 *Independent samples t-test*

Variable	Regular exercisers (<i>n</i> = 99) (<i>M</i> ± <i>SD</i>)	Non-regular exercisers (<i>n</i> = 74) (<i>M</i> ± <i>SD</i>)	Mean Diff (95% CI)	<i>D</i>
Overall MT	3.43 ± .41	3.26 ± .55*	.18 (.03, .33)	.35
Challenge	3.58 ± .52	3.48 ± .59	.10 (-.07, .27)	.18
Commitment	3.58 ± .52	3.37 ± .63**	.22 (.04, .39)	.36
Emotional control	2.91 ± .64	2.79 ± .75	.12 (-.09, .33)	.17
Life control	3.49 ± .45	3.39 ± .68	.10 (-.08, .28)	.17
Confidence in abilities	3.24 ± .63	3.00 ± .75*	.25 (.03, .46)	.35
Interpersonal confidence	3.60 ± .68	3.38 ± .82*	.22 (.00, .46)	.29
Overall barriers	3.21 ± .48	2.68 ± .45***	.53 (.39, .67)	1.14
Exercise milieu	3.30 ± .58	2.74 ± .53***	.56 (.39, .72)	1.01
Physical exertion	2.70 ± .77	2.20 ± .67***	.49 (.27, .71)	.69
Time expenditure	3.40 ± .58	2.80 ± .81***	.60 (.39, .82)	.85
Family discouragement	3.42 ± .62	3.03 ± .69***	.39 (.19, .59)	.60

3 *Note.* A higher MT score represents higher MT, a higher exercise barrier score represents a weaker barrier.4 * Statistically significant at $p < 0.05$.5 **Statistically significant at $p < 0.01$.6 *** Statistically significant at $p < 0.001$.

1 Table 3

2 *Standardized path estimates with 95% bootstrapped confidence intervals*

Variable	Exercise milieu	Physical exertion	Time expenditure	Family discouragement
Challenge	.06 (-.26, .36)	.06 (-.24, .32)	.04 (-.21, .28)	-.01 (-.27, .25)
Commitment	.12 (-.12, .35)	.20 (-.08, .46)*	-.07 (-.32, .18)	.03 (-.23, .30)
Emotional control	-.22 (-.45, .02)*	-.07 (-.33, .19)	-.24 (-.51, .04)*	-.01 (-.29, .27)
Life control	.18 (-.11, .47)	-.05 (-.33, .27)	.03 (-.31, .38)	.13 (-.20, .41)
Confidence in abilities	.27 (-.05, .53)*	.21 (-.10, .51)	.41 (.07, .72)**	.13 (-.20, .46)
Interpersonal confidence	-.02 (-.22, .18)	-.09 (-.33, .17)	.02 (-.23, .25)	.03 (-.20, .26)

3 *Note.* * Statistically significant at $p < 0.05$; **Statistically significant at $p < 0.01$.