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Psychological and behavioral correlates of early adolescents' physical literacy

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Abstract

Purpose. Physical literacy is understood to be important for adolescents' behavioral and psychological wellness. Yet, to date, limited empirical data exists to support such reasoning. Addressing this gap, the present study examined relationships between physical literacy and early adolescents' physical education (PE) engagement, leisure-time exercise behavior, and psychological well-being. **Method.** The physical literacy level of 187 early adolescents ($M_{age} = 12.84$, $SD = .55$, girls = 99) was measured using the Canadian Assessment for Physical Literacy (Healthy Active Living and Obesity Research Group, 2014). One week later, data pertaining to standardized measures of engagement in PE, leisure-time exercise behavior, and psychological well-being were collected. **Results.** Structural equation modeling revealed that physical literacy was positively correlated with PE engagement, leisure-time exercise, positive affect, and vitality, whereas it was negatively correlated with negative affect. **Conclusion.** Findings from this work substantiate the contention that physical literacy has manifold benefits for an early adolescents' behavioral and psychological wellness.

Keywords: Physical education, engagement, exercise, well-being.

1 **Introduction**

2 Physical literacy is understood to be important for child and adolescent development
3 and health (e.g., Society of Health and Physical Educators America [SHAPE], 2013; United
4 Nations Educational, Scientific and Cultural Organization [UNESCO], 2015; Whitehead,
5 2010). To date, physical literacy has been largely studied in regard to conceptualization,
6 measurement, usefulness, and practical development (e.g., Tremblay & Lloyd, 2010;
7 Whitehead, 2010). Such work has supported the adoption of several physical literacy
8 interventions that show promise in supporting the health and well-being of children and
9 adolescents (e.g., SHAPE, 2013; UNESCO, 2015). Yet despite advancements in
10 measurement, it is surprising that very few studies have investigated the health-related
11 behavioral and psychosocial outcomes of physical literacy. This study will therefore address
12 this void in the extant literature by testing relationships between physical literacy and
13 engagement in physical education (PE), leisure-time exercise behavior, and psychological
14 well-being.

15 **Physical Literacy**

16 One of the most widely cited definitions of physical literacy describes it as the
17 motivation, confidence, physical competence, knowledge and understanding to value and take
18 responsibility for engagement in physical activities for life (International Physical Literacy
19 Association, 2017). From this perspective, physical literacy is considered a holistic construct
20 that encompasses not only a physical component, but also cognitive (i.e., knowledge and
21 understanding), psychological (i.e., motivation and confidence) and behavioral (i.e., physical
22 activity behavior) elements. Recently, a large-scale empirical study of physical literacy (Royal
23 Bank of Canada Learn to Play-Canadian Assessment of Physical Literacy, 2018) has been
24 reported by Tremblay and his colleagues using their Canadian Assessment of Physical
25 Literacy (CAPL) measurement tool (Healthy Active Living and Obesity Research Group

1 [HALO], 2014; Longmuir et al., 2015; Tremblay et al., 2018). The CAPL is currently the
2 only, and widely accepted, measurement tool available for assessing holistic physical literacy
3 that has peer-reviewed support for its systematic development, validity, and reliability
4 (HALO, 2014; Francis et al., 2016; Longmuir et al., 2015). Within the CAPL, an overall
5 physical literacy score is calculated based on measures relating to the four domains identified
6 by the International Physical Literacy Association definition (i.e., physical competence,
7 motivation and confidence, knowledge and understanding, daily behavior). Initial data from a
8 sample of 10,034 Canadian children showed that boys and older children tended to have
9 higher levels of physical literacy than girls and younger children (Tremblay et al., 2018).

10 Using the Royal Bank of Canada Learn to Play-CAPL data, associations among the
11 different aspects of physical literacy have been reported (Belanger et al., 2018; Lang et al.,
12 2018). Lang et al. (2018) reported a positive relationship between overall physical literacy and
13 cardiorespiratory fitness. Similarly, Belanger et al. (2018) reported a positive relationship
14 between physical literacy and physical activity and a negative relationship between physical
15 literacy and sedentary behavior. Collectively, these findings provide initial insight into the
16 value of physical literacy, yet further empirical research exploring the relationships between
17 physical literacy and a broader array of health and well-being outcomes is needed (Longmuir
18 & Tremblay, 2016). In this study, we focus on outcomes related to engagement in school PE,
19 self-reported leisure-time exercise behavior, and psychological well-being.

20 **Physical literacy and engagement in school PE**

21 Engagement, broadly defined, is an individual's level of active involvement in a
22 learning activity (Skinner & Belmont, 1993). When engaged, individuals demonstrate focus,
23 interest, and persistence (Reeve, Jang, Carrell, Jeon & Barch, 2004). In school contexts,
24 engaged pupils are believed to challenge themselves, act independently, and exert intense
25 effort and concentration and generally show positive emotions such as enthusiasm, optimism

1 and curiosity when completing tasks (Skinner & Belmont, 1993). To this end, empirical
2 research has shown engagement to be positively associated with several adaptive outcomes in
3 school, including greater achievement, enhanced learning, and better skill development
4 (Skinner & Belmont, 1993). When assessed in school contexts, academic engagement has
5 been measured via four core elements, namely behavioral (i.e., active participation with effort
6 and persistence), cognitive (i.e., psychological investment in learning and cognition within
7 tasks), emotional (i.e., feelings in relation to teachers, peers and school), and agentic (i.e.,
8 student contribution to the flow and instruction received) (Reeve & Tseng, 2011).

9 Although engaged participation in PE is considered important for physical activity and
10 health (Sallis et al., 2012), researchers have not explored the interplay among physical literacy
11 and PE engagement. This is somewhat surprising as physical literacy and its components are
12 likely to be highly influential in how pupils behave, think, and feel in PE. For instance, one
13 component of physical literacy – motivation – is well understood to be influential in pupil
14 engagement (e.g., Curran, Hill, Ntoumanis, Hall, & Jowett, 2016; Reeve et al, 2004).
15 Relatedly, competence is an important antecedent of well-integrated motivation (Ryan &
16 Deci, 2017) and as such, integration of physical competence and confidence within physical
17 literacy makes it likely to also be influential in PE engagement. Other research is also
18 suggestive. Two systematic reviews demonstrate a positive relationship between motor
19 competence (a component of physical competence) and behavioral engagement in physical
20 activity broadly (Lubans, Morgan, Cliff, Barnett & Okely, 2010). Likewise, the reported
21 positive relationship established between children’s physical literacy and physical activity
22 behavior (Belanger et al., 2018) provides further evidence of the importance of physical
23 literacy towards behavioral engagement to physical activity. Further, higher levels of motor
24 skills have been shown to relate to enhanced moderate to vigorous physical activity (MVPA)

1 time in PE (Fairclough, Stratton & Baldwin, 2002). Collectively, theory and research suggest
2 that physical literacy is likely to share a positive association with engagement in PE.

3 **Physical literacy and leisure-time exercise behavior**

4 Participation in regular exercise or physical activity during adolescence has long been
5 associated with a range of positive health outcomes (Hallal, Victoria, Azevedo, & Wells,
6 2006; Janssen & LeBlanc, 2010; Poitras et al., 2016; Telema et al., 2014). Although the terms
7 are often used interchangeably, physical activity concerns any bodily movement that results in
8 energy expenditure, whereas exercise reflects the planned and purposeful engagement with
9 physical activity (Caspersen, Powell, & Christenson, 1985). Individuals are likely to engage
10 in physical activity behaviors of varying frequencies, intensities, durations, and types
11 throughout their daily lives. However, sufficient time periods of MVPA are currently
12 advocated for health benefit (World Health Organization [WHO], 2010). For young people, a
13 minimum of 60 minutes MVPA per day is recommended (WHO, 2010). Yet, data show that
14 only a limited number of young people meet MVPA recommendations worldwide (Sallis et
15 al., 2016; Tremblay et al., 2016). Given that much incidental physical activity has been
16 engineered out of daily living (Katzmarzyk & Mason, 2009), more purposeful engagement in
17 physical activity during free time (i.e., leisure-time exercise) is often required to achieve
18 health-enhancing levels of physical activity. Thus, it is important to understand the factors
19 associated with leisure-time exercise behavior.

20 Physical literacy may be one construct that is positively associated with exercise
21 behavior because its core components (i.e., physical competence, motivation, confidence and
22 knowledge, and understanding) are considered important correlates or determinants of
23 lifelong physical activity (Longmuir & Tremblay, 2016). Evidence is generally supportive of
24 the importance of physical literacy towards exercise behaviors and overall physical activity in
25 young people (e.g., Belanger et al., 2018; Biddle, Atkin, Cavill, & Foster, 2011). The

1 relationship between physical literacy and physical activity during free time (i.e., leisure-time
2 exercise) is, however, yet to be explored. However, research appears supportive of a positive
3 relationship. For example, Taylor, Ntoumanis, Standage, and Spray (2010) reported that
4 perceived competence positively predicted exercise intentions and leisure-time physical
5 activity during adolescence. Similarly, research has shown adolescents' perceived athletic
6 competence at the beginning of the academic year to predict sport and exercise participation
7 7- and 14-months later (Papaioannou, Bebetos, Theodorakis, Christodoulidis, & Kouli,
8 2006). Further, during childhood, higher levels of motor coordination at baseline have been
9 found to predict sport participation (considered volitional) two years later (Vandorpe et al.,
10 2012). As such, we consider theory and past research to be supportive of a positive
11 relationship between physical literacy and leisure-time exercise behavior.

12 **Physical literacy and psychological well-being**

13 Alongside engagement in PE and leisure-time exercise behavior, physical literacy is
14 likely to contribute to psychological well-being among children and adolescents.
15 Psychological well-being is a multidimensional construct consisting the presence of positive
16 affect, the absence of negative affect, and the presence of vitality (Ryan & Frederick, 1997).
17 Positive and negative affect are hedonic indicators of psychological well-being and
18 encapsulate feelings of pleasure or distress respectively. Vitality is a eudemonic form of
19 psychological well-being and encapsulates a relative state of "energy and aliveness" (Ryan &
20 Frederick, 1997, p. 530). Recent reports document a rise in mental health issues amongst
21 young people, thus there is an urgent need to explore factors related to the psychological well-
22 being of children and adolescents (WHO, 2017).

23 As a construct that draws upon factors from a range of domains (i.e., physical,
24 affective, cognitive), physical literacy may represent an important foundation to young
25 people's psychological well-being. Indeed, and drawing upon the philosophical concept of

1 embodiment, Whitehead (2010) proposed that physical literacy is an important individual
2 capability that makes a significant contribution to quality of life. One potential mechanism
3 linking physical literacy to enhanced psychological well-being is via physical competence and
4 associated perceptions of competence (i.e., confidence). Indeed, experiencing perceptions of
5 competence is considered essential for psychological growth and wellness (Ryan & Deci,
6 2017). Research supports these ideas. For example, studies have demonstrated a positive
7 association between satisfaction of the psychological need for competence in physical activity
8 related contexts and aspects of psychological well-being (e.g., Standage, Duda, & Ntoumanis,
9 2003; Standage & Gillison, 2007). Additionally, higher levels of physical competence have
10 been associated with more pleasurable physical activity experiences (Carroll & Loumidis,
11 2001). Collectively, then, theory and past research are supportive of a positive association
12 between physical literacy and psychological well-being.

13 **The Present Study**

14 Physical literacy has been identified as being influential for child and adolescent
15 health. Yet to date very little research has been conducted to examine the outcomes of
16 physical literacy. Accordingly, the aim of this study was to test associations of physical
17 literacy with early adolescents' PE engagement, leisure-time exercise behavior, and
18 psychological well-being (i.e., indexed by scores to measures of positive affect, negative
19 affect, and vitality). Based on the aforementioned theory and past empirical research, we
20 hypothesized that physical literacy would positively correlate with PE engagement, leisure-
21 time exercise behavior, vitality, and positive affect. By contrast, it was hypothesized that
22 physical literacy would negatively correlate with negative affect.

23 **Method**

24 **Participants and Procedure**

1 Prior to commencing the study, ethical approval was provided by the research ethics
2 approval committee of the lead author's university. A sample of 187 participants ($M_{age} =$
3 12.84, $SD=.55$, girls = 99, boys = 87, ethnicity = 93% White) were recruited from two schools
4 from South Wales. These participants were invited to complete the Canadian Assessment for
5 Physical Literacy (CAPL: HALO, 2014). Following the CAPL guidance (HALO, 2014), the
6 CAPL was administered over a two-day period. On day one, participants completed the
7 obstacle course, plank and anthropometric measures, and were issued with a pedometer. On
8 day two, participants completed PACER test, sit and reach test, grip strength test, and
9 completed the CAPL questionnaire. Pedometers were collected after a minimum of eight days
10 at a convenient time for schools. One week following the CAPL measurements, a multi-item
11 questionnaire pack was administered to assess the participants' engagement in PE, leisure-
12 time exercise behavior, positive and negative affect, and vitality. Data were collected
13 throughout the school year.

14 **Instruments**

15 **Physical literacy.** The Canadian Assessment for Physical Literacy, Version 1 (CAPL;
16 HALO, 2014) was used to measure physical literacy. An overall physical literacy score (out of
17 100) is calculated from the CAPL from the subcomponent scores of daily behavior,
18 motivation and confidence, knowledge and understanding, and physical competence. Based
19 on their overall physical literacy score, participants are categorized as 'beginning',
20 'progressing', 'achieving', or 'excelling' on their physical literacy journey.

21 Daily behavior was assessed using a seven-day pedometer step count protocol and via
22 self-reported MVPA and sedentary behavior. A pedometer (Fastime-Ped 1, Leicestershire,
23 England) was distributed to all participants to wear for eight consecutive days. Consistent
24 with the CAPL manual (Version 1), participants recorded their daily step count using the
25 pedometer tracking log provided in the CAPL manual (HALO, 2014). Day one was used as a

1 familiarization day and these data were not recorded and used in analysis. As outlined in the
2 CAPL manual (HALO, 2014), a minimum wear time of 10 hours per day (Eisenmann,
3 Laurson, Wickel, Gentile, & Walsh, 2007), and step counts between 1,000 and 30,000 steps
4 were considered valid (Tudor Locke, McClain, Hart, Sisson, & Washington, 2009). Further, at
5 least three or more valid days of pedometer measurement was required to be included in the
6 final analysis (Tudor-Locke et al., 2009). As outlined in the CAPL manual, pedometer step
7 counts provide a more direct, objective measure for physical activity than self-reported data
8 (HALO, 2014). Moreover, and in comparison to accelerometers, the relatively low cost,
9 simplicity of initialization and analysis, reliability, and unobtrusive nature of pedometers
10 make them an ideal tool for researchers to use with large samples (Colley, Janssen &
11 Tremblay, 2012). Previous research with the CAPL has supported the effectiveness of
12 following these protocols for collecting and analyzing pedometer step counts with groups of
13 young people (e.g., Tremblay et al., 2018; see Corder, Ekelund, Steele, Wareham & Brage,
14 2008 regarding the reliability and validity of different methods of assessing physical activity).
15 MVPA levels were recorded via self-report of the number of days in the past week that
16 participants were physically active for at least 60 minutes. Specifically, participants were
17 asked “During the past week (7 days), on how many days were you physically active for a
18 total of at least 60 minutes per day? (all the time you spent in activities that increased your
19 heart rate and made you breathe hard).” Sedentary behavior scores were calculated from
20 participant responses to the number of hours they usually spend watching TV and playing
21 video games on a school day or a weekend day. Information on the validity and reliability of
22 scores to these self-reported measures have previously been reported in the Youth Risk
23 Behavior Surveillance System (Brener et al., 2013). Pedometer scores, MVPA, and sedentary
24 behavior scores were calculated using the scoring systems provided in the CAPL manual

1 (HALO, 2014). A total daily behavior score out of 32 was calculated by adding the CAPL
2 pedometer step score to the total screen time score and the weekly time spent in MVPA.

3 Motivation and confidence were assessed using the Children's Self-Perceptions of
4 Adequacy in and Predilection for Physical Activity (CSPAPPA; Hay, 1992). This scale
5 requires participants to respond to a range of items in answer to the stem "what is most like
6 you". Participants firstly select from two options (e.g., Adequacy – "some kids are good at
7 active games" or "other kids find active games hard to play", and Predilection – "some kids
8 don't like playing active games"), before outlining if the statements were "really true" or "sort
9 of true" for them. Individual adequacy and predilection items are scored from one to four.
10 Adequacy scores were then summed, multiplied by 1.5 and divided by seven (HALO, 2014).
11 Predilection scores were summed and divided by nine (HALO, 2014). Overall motivation and
12 confidence scores were calculated by adding the adequacy and predilection scores.
13 Participants also respond to two individual items asking them to rate their own activity and
14 skill levels with that of their peers on a 1-10 Likert scale. This score is divided by 10 and
15 added to the adequacy and predilection scores to provide an overall motivation and
16 confidence out of 14. The benefits to barriers ratio score was not included due to issues with
17 children misunderstanding items from this measure. Similar findings have been reported
18 elsewhere (e.g., Gunnell et al., 2018). However, and in order to maintain an overall score out
19 of 18 for the motivation and confidence domain, a fractional method was used to scale the
20 score out of 14 up to 18. The overall score out of 14 was divided by 14 then multiplied by 18.
21 Scores provided to the CSPAPPA have previously shown good test-retest reliability and
22 adequate validity (Hay, 1992).

23 Knowledge and understanding was assessed using the questionnaire developed
24 specifically for the CAPL (HALO, 2014). Within this, an overall knowledge and
25 understanding score out of 18 is calculated from participant responses to items relating to the

1 participant's knowledge of the physical activity and sedentary behavior recommendations,
2 awareness of fitness and movement skill parameters and methods for their improvement, use
3 of safety equipment during physical activity and perceptions of health (HALO, 2014;
4 Longmuir et al., 2015). An example item for the knowledge and understanding component
5 asked participants to circle one of four responses to the question, "if your wanted to get better
6 at a sport skill like kicking and catching a ball, what would be the best thing to do?" Scores
7 provided to the knowledge and understanding domain have been shown to provide support for
8 the factorial structure of this component as part of an overall physical literacy score
9 (Longmuir et al., 2015).

10 Finally, physical competence was calculated by adding the participants CAPL scores
11 for motor competence, musculoskeletal fitness, cardiorespiratory fitness, and body
12 composition (HALO, 2014). Motor competence was calculated from individual scores on the
13 Canadian Agility and Movement Skill Assessment (CAMSA; Longmuir et al., 2017).
14 Participant skills within the CAMSA were assessed by the lead author. Musculoskeletal
15 fitness was calculated from pupils scores on the sit and reach assessment of flexibility
16 (Canadian Society for Exercise Physiology, 2013), an assessment of grip strength (Canadian
17 Society for Exercise Physiology, 2013), and the assessment of plank torso strength (Boyer et
18 al., 2013). Cardiorespiratory fitness was assessed using the Fitnessgram 20m progressive
19 aerobic cardiovascular endurance run (PACER; Meredith & Welk, 2010). Finally, body
20 composition was assessed using body mass index (height, weight; Canadian Society for
21 Exercise Physiology, 2013) and waist circumference (Canadian Society for Exercise
22 Physiology, 2013). The overall score for physical competence out of 32 was calculated using
23 the scoring system outlined in the CAPL manual (HALO, 2014).

24 Scores provided to the CAPL have been shown to provide a valid and reliable measure
25 of physical literacy, as defined by the International Physical Literacy Association (2017).

1 First, extensive development of the CAPL via a 3-round Delphi process with 19
2 internationally-leading physical activity/fitness experts ensured agreement on the validity of
3 the overall conceptualization, the specific assessment protocols included, and the scoring
4 system incorporated within the measure (Francis et al., 2016). Second, further testing of the
5 CAPL with a large sample of participants demonstrated acceptable factorial structure for the
6 measure along with close relationships with teacher derived ratings (Longmuir et al., 2015).

7 **Engagement in PE.** Engagement in PE was measured using an adapted version of the
8 classroom engagement measure developed by Reeve and Tseng (2011). This measure assesses
9 agentic (e.g., “during PE, I ask questions”), behavioral (e.g., “I pay attention in PE”),
10 emotional (e.g., “PE is fun”) and cognitive (e.g., “when I study, I try to relate what I’m
11 learning to what I already know”) components of engagement. Participants were asked to
12 respond to 19-items on a 7-point Likert scale to indicate the extent to which they agree.
13 Scores to this measure have previously demonstrated acceptable factorial structure and
14 internal consistency ($\alpha = .87$; Cheon, Reeve & Moon, 2012; Reeve & Tseng, 2011).

15 **Leisure-time exercise behavior.** Leisure-time exercise behavior was assessed using
16 the Leisure Time Exercise Questionnaire (LTEQ; Godin & Shephard, 1997). Responses to the
17 LTEQ require participants to report how many times over a typical week they have spent
18 undertaking strenuous, moderate and light exercise of at least 15 minutes during their free
19 time. An overall leisure-time exercise score is calculated using the following formula (total
20 exercise score = [number of strenuous bouts x 9] + [number of moderate bouts x 5] + [number
21 of light bouts x 3]). Scores to this measure have demonstrated support for the LTEQ’s
22 psychometric properties in child samples (e.g., Biddle, Gorely, Pearson, & Bull, 2011). For
23 example, a test-retest reliability coefficient of $\alpha = .74$ has been reported (Godin & Shephard,
24 1985). Further, validity and reliability of LTEQ scores have been judged as acceptable in two

1 reviews (Biddle, Gorely, Pearson, & Bull, 2011; Hidding, Chinapaw, van Poppel, Mokkink,
2 & Altenburg, 2018).

3 **Psychological well-being.** The 10-item positive and negative affect schedule for
4 children (PANAS-C; Ebesutani et al., 2012) was used to assess the participants' positive and
5 negative affect. To assess positive affect, participants reported the extent to which they felt
6 happy, cheerful, proud, joyful, and lively, over the past few weeks using a 5-point Likert
7 scale. Conversely, to assess negative affect, participants indicated on the same Likert scale,
8 the extent to which they felt sad, scared, miserable, afraid, and mad. Scores provided to the
9 PANAS-C have demonstrated acceptable factorial structure and internal consistency (i.e.,
10 positive affect $\alpha = .86$, negative affect $\alpha = .82$; Ebesutani et al., 2012). Vitality was measured
11 using the subjective vitality scale (Ryan & Frederick, 1997; Bostic, Rubio, & Hood, 2000).
12 Within this tool, participants responded to 6-items (e.g., "I feel alive and vital") on a 7-point
13 Likert scale. Scores provided to the subjective vitality scale have been shown to support
14 acceptable factorial structure (Ryan & Frederick, 1997) and good internal consistency in
15 adolescent samples (e.g., $\alpha = .88$; Taylor & Lonsdale, 2010).

16 **Analytic Strategy**

17 Initially, descriptive statistics (i.e., means, standard deviations, correlations, alpha
18 coefficients) were calculated. Using AMOS version 22.0 (Arbuckle, 2013), the main analysis
19 was then undertaken using two-phased structural equation modeling procedure (Anderson &
20 Gerbing, 1988). Initially, a measurement model was tested using confirmatory factor analysis
21 (CFA). This enabled the adequacy of the relationships between individual items and their
22 latent constructs to be examined. Following the CFA, a structural equation model
23 encompassing the hypothesized relationships was tested. The overall fit of data for both the
24 measurement and structural models was assessed by using a set of fit indices which compare
25 the variance-covariance matrix of the sample data to the variance-covariance matrix of the

1 model-implied data. A close match between sampled and hypothesized variances and
2 covariances, as indicated by the fit statistics, would show the hypothesized data to be
3 adequately represented by the sample data. The fit of the measurement and structural models
4 were determined using conventional standards and deemed acceptable if CFI and TLI $\geq .90$
5 and RMSEA and SRMR $\leq .10$ (Marsh, Hau, & Wen, 2004). Statistical significance was set at
6 $p = .05$. Effect sizes were calculated as the proportion of variance shared by physical literacy
7 and each dependent variable using the coefficient of determination (i.e., R^2).

8 **Results**

9 **Preliminary Analysis**

10 One hundred and eighty-seven children commenced the CAPL physical competency
11 protocols, CAPL questionnaire, and were administered with a pedometer. Missing value
12 analysis showed that 127 participants had complete physical competency data (i.e., nine
13 complete protocols). Missing physical competence data emerged as a result of absence on day
14 of testing ($n = 32$) and declining participation on a specific protocol ($n = 28$). Following the
15 CAPL manual guidance (HALO, 2014, p.18), a fractional method was used to calculate an
16 overall physical competence score from the participants' available protocol results.
17 Additionally, 68 participants (36%) failed to provide valid pedometer data (HALO, 2014),
18 leading to further missing data. Given that a total physical literacy score can be calculated
19 with a maximum of one complete missing protocol (HALO, 2014; Francis et al., 2016),
20 participants with only the pedometer step count score missing were retained in the sample.

21 To maintain the pattern of physical literacy scores, for participants only missing the
22 pedometer step count score, a fractional imputation method was used. Here, the overall
23 physical literacy score (out of 100) was determined by dividing the total score recorded from
24 the completed protocols by the maximum possible score (i.e., 79), and then multiplying this
25 number by 100. This yielded a final sample of 158 with complete physical literacy data. Of

1 these, 150 were available to complete the follow up questionnaire pack. Analysis of missing
2 values at time point two revealed 14 participants with over 10% missing data or incomplete
3 leisure time exercise data. These participants were removed, leaving a total of 136
4 participants. A mean-substitution from the completed sub-scale items was utilized to impute
5 remaining missing data. In accordance with Tabachnick and Fidell (2007), 11 significant
6 univariate outliers were identified and removed (z -scores larger than 3.29, $p < .001$) and no
7 multivariate outliers were identified using Mahalanobis distances greater than $\chi^2(9) = 27.88$
8 ($p < .001$). Following the removal of these cases, a final sample of 125 participants was
9 available for analysis ($M_{age} = 12.82$, $SD = .54$, girls = 69, boys = 55, 1 not disclosed).

10 Bivariate correlations, means, standard deviations, and alpha coefficient values are
11 shown in Table 1. Analyses revealed positive relationships between physical literacy and all
12 elements of PE engagement, leisure-time exercise behavior, positive affect, and vitality. There
13 was a negative correlation between physical literacy and negative affect. These findings lend
14 initial support to our hypotheses.

15 **Primary analysis**

16 The measurement model contained four latent variables (PE engagement with four
17 sub-scale indicators, positive affect with 5 item indicators, negative affect with 5 item
18 indicators, and vitality with 6 item indicators) and two observed variables (physical literacy
19 and leisure time physical activity). Covariances were specified between the disturbance terms
20 of positive affect, negative affect, and vitality to reflect the common association among these
21 variables in previous empirical research (e.g., Gagne, Ryan & Bargmann., 2003). Analyses of
22 individual factor loadings from the measurement model revealed two items from the negative
23 affect scale loaded poorly (i.e., $< .40$; Hair, Black, Babin, & Anderson, 2010) onto their
24 respective latent variable and were therefore removed. With these items removed, the
25 measurement model demonstrated good fit to the data (TLI = .94, CFI = .95, $\chi^2 = 205.01$

1 (157), $p < .05$, RMSEA = .05, SRMR = .06). In stage two, the hypothesized structural model
2 was tested. Fit statistics showed the structural model to have an adequate fit to the data (TLI =
3 .91, CFI = .93, $\chi^2 = 236.59$ (164), $p < .05$, RMSEA = .06, SRMR = .11). Detailed analysis of
4 the structural model showed several significant relationships between the study variables that
5 are presented in Figure 1. Physical literacy was significantly and positively related to
6 engagement in PE ($\beta = .57$, $p < .001$, $R^2 = .33$), levels of leisure-time exercise ($\beta = .38$, $p <$
7 $.001$, $R^2 = .14$), vitality ($\beta = .53$, $p < .001$, $R^2 = .28$), positive affect ($\beta = .39$, $p < .001$, $R^2 =$
8 $.15$), and significantly and negatively related to negative affect ($\beta = -.25$, $p < .05$, $R^2 = .06$).
9 Overall, physical literacy explained 33% of variance in PE engagement, 14% of variance in
10 leisure-time exercise, 28% of variance in vitality, 15% of variance in positive affect, and 6%
11 of variance in negative affect.

12 Discussion

13 As recently highlighted by scholars (e.g., Longmuir & Tremblay, 2016), an important
14 and missing avenue of research pertains to better understanding the outcomes of physical
15 literacy. In an initial attempt to address this gap, we examined the relationships between
16 physical literacy and engagement in PE, leisure-time exercise behavior, and the psychological
17 well-being of early adolescents. Using a prospective design, the results of the present work
18 support the importance of physical literacy by demonstrating positive relationships between
19 physical literacy and engagement in PE, leisure-time exercise behavior, and psychological
20 well-being as well as a negative association between physical literacy and negative affect.

21 Physical Literacy and Engagement in PE

22 Results of this study showed a positive relationship between physical literacy and
23 engagement in PE. The positive association with physical literacy and engagement in PE has
24 several important implications. First, as a context that provides structured physical activity
25 experiences for all young people, engagement in PE is highly salient for physical health (e.g.,

1 Fairclough, Stratton, & Baldwin, 2002; Sallis et al., 2012). One of the ways through which
2 physical literacy may enhance physical health, then, is via heightened engagement in PE.
3 Second, our findings highlight the potential risks of disengagement from secondary school PE
4 among pupils who have not yet developed adequate levels of physical literacy. It appears
5 essential that physical educationalists consider how their pedagogical approaches support the
6 needs of all pupils and particularly those with lower levels of physical literacy. Strategies such
7 as making activities meaningful and relevant, providing choice, optimal challenge, and
8 structure are essential (Ntoumanis & Standage, 2009). Finally, research shows that
9 engagement and motivation share a reciprocal relationship (e.g., Curran et al., 2016). Hence, it
10 is likely that just as physical literacy contributes to PE engagement, PE engagement may also
11 contribute to physical literacy.

12 **Physical Literacy and Leisure-Time Exercise**

13 We also found that physical literacy shared a positive association with leisure-time
14 exercise. This finding adds to the recent results of Belanger et al.'s (2018) work wherein they
15 reported a positive relationship between physical literacy and physical activity and a negative
16 association between physical literacy and sedentary behavior. Considering that much
17 incidental physical activity has been removed from daily lives (Katzmarzyk & Mason, 2009),
18 achieving health-enhancing levels of physical activity requires participation in more
19 purposeful activity (i.e., leisure-time exercise). Thus, the positive relationship between
20 physical literacy and leisure-time exercise behavior reported in our work has important health
21 implications for young people. First, short-term benefits of exercise participation include
22 enhanced musculoskeletal and cardiovascular health and fitness, lowered fat mass, and higher
23 self-esteem (Hallal et al., 2006; Janssen & LeBlanc, 2010). Second, longer-term benefits may
24 be associated with participation in leisure-time exercise during adolescence, potentially, via

1 the tracking of exercise behaviors into young adulthood and/or by offsetting the development
2 of future health conditions (Hallal et al., 2006; Telema et al., 2014).

3 **Physical Literacy and Psychological Well-being**

4 The results from this study also demonstrated a positive relationship between physical
5 literacy and positive affect and vitality. Conversely, physical literacy shared a negative
6 association with negative affect. Previous research has demonstrated positive relationships
7 between physical activity and psychological well-being (Poitras et al., 2016). Further, within
8 her philosophical basis for physical literacy, Whitehead (2010) suggests that being “physically
9 literate can make a significant contribution to quality of life” (p. 32). The positive
10 relationships found between physical literacy and positive affect and vitality lends support to
11 these ideas. Here, our findings indicate how, in addition to developing physical health,
12 supporting the development of physical literacy can also hold important psychological
13 benefits for young people. This is particularly important given the rising mental health issues
14 reported amongst young people (WHO, 2017), with our findings suggesting that physical
15 literacy may be one pathway through which these issues might be alleviated.

16 **Limitations and future research**

17 This study has limitations. The homogenous nature of the sample means that findings
18 cannot be generalized. Relatedly, the small effective sample size used is also a limitation.
19 Future research should therefore aim to further explore outcomes associated with physical
20 literacy in larger and more diverse samples. The recent release of a streamlined CAPL 2.0
21 (HALO, 2017) enhances the practicalities of such research by decreasing the burden on
22 participants, gatekeepers, and researchers. However, the use of this tool is not without
23 challenges. Specifically, we were able to maintain sample size in our study through following
24 guidance in the CAPL 1.0 manual (HALO, 2014) to maintain some participants only missing
25 pedometer step count within our sample. Yet, in the CAPL 2.0, this is not advised, meaning

1 future research may require large sample sizes to account for attrition. Further, detailed
2 analysis of the true nature of missing pedometer data is advised. Additionally, some
3 participants in our sample were 12-13 years of age, slightly above the age range of the CAPL.
4 However, at present there is not an alternative, validated measure for assessing the physical
5 literacy of adolescents. Future work should seek to address this gap. Yet, it is of note that a
6 ceiling effect was not detected in the sample, hence suggesting the CAPL to potentially be a
7 suitable measure of physical literacy for 13-year old pupils. Next, and despite the prospective
8 nature of the research design, the data remains correlational and therefore causal relationships
9 cannot be inferred. Likewise, we cannot ascertain the directionality of relations. In the case of
10 PE engagement and leisure-time exercise, reciprocal relationships are especially likely.
11 Longitudinal research is therefore required to monitor variables over time. Finally, and
12 although past work has demonstrated mean differences among physical literacy dimensions to
13 exist (Tremblay et al., 2018), it would be interesting in future work with appropriately
14 powered sample to examine the invariance of associations among physical literacy and
15 outcome variables across potentially important covariates such as age (including relative age
16 effect), gender, socioeconomic status, and cultural background.

17 **Conclusion**

18 This study adds to a vastly limited body of empirical research examining the correlates
19 of physical literacy in early adolescents. The present findings show physical literacy to
20 contribute to a number of adaptive outcomes including PE engagement, leisure-time exercise
21 behavior, and psychological well-being. As such, our findings support the longstanding
22 contention that physical literacy contributes to young people's development, health, and
23 wellness. Further to this, our data also adds to the assertion that the development of physical
24 literacy should be a target of early intervention (Whitehead, 2010).

25

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1 *Table 1*

2 Means, Standard Deviations, Reliabilities, and Correlations between Study Variables

| Variable | <i>M</i> | <i>SD</i> | <i>α</i> | 1 | 2 | 3 | 4 | 5 | 6 | 7 | 8 | 9 | 10 |
|-----------------------------------|----------|-----------|----------|-------|-------|-------|-------|-------|-------|-------|--------|--------|----|
| 1. Physical literacy | 68.77 | 10.47 | - | - | | | | | | | | | |
| 2. Engagement in PE | 4.96 | .83 | - | .50** | - | | | | | | | | |
| 3. Agentic engagement | 3.99 | 1.17 | .83 | .37** | .77** | - | | | | | | | |
| 4. Behavioral engagement | 5.81 | .80 | .81 | .38** | .75** | .39** | - | | | | | | |
| 5. Emotional engagement | 5.45 | 1.16 | .86 | .51** | .82** | .51** | .64** | - | | | | | |
| 6. Cognitive engagement | 4.69 | 1.16 | .87 | .31** | .77** | .41** | .44** | .49** | - | | | | |
| 7. Leisure-time exercise behavior | 60.41 | 33.36 | - | .38** | .30** | .21* | .22* | .24** | .26** | - | | | |
| 8. Positive affect | 3.79 | .70 | .78 | .39** | .47** | .31** | .33** | .47** | .37** | .23** | - | | |
| 9. Negative affect | 1.65 | .55 | .61 | -.19* | -.05 | .05 | -.12 | -.05 | -.06 | .02 | -.31** | - | |
| 10. Vitality | 4.70 | 1.12 | .86 | .52** | .59** | .43** | .42** | .53** | .45** | .28** | .75** | -.31** | - |

3 ** . Correlation is significant at the 0.01 level (2-tailed).

4 * . Correlation is significant at the 0.05 level (2-tailed).

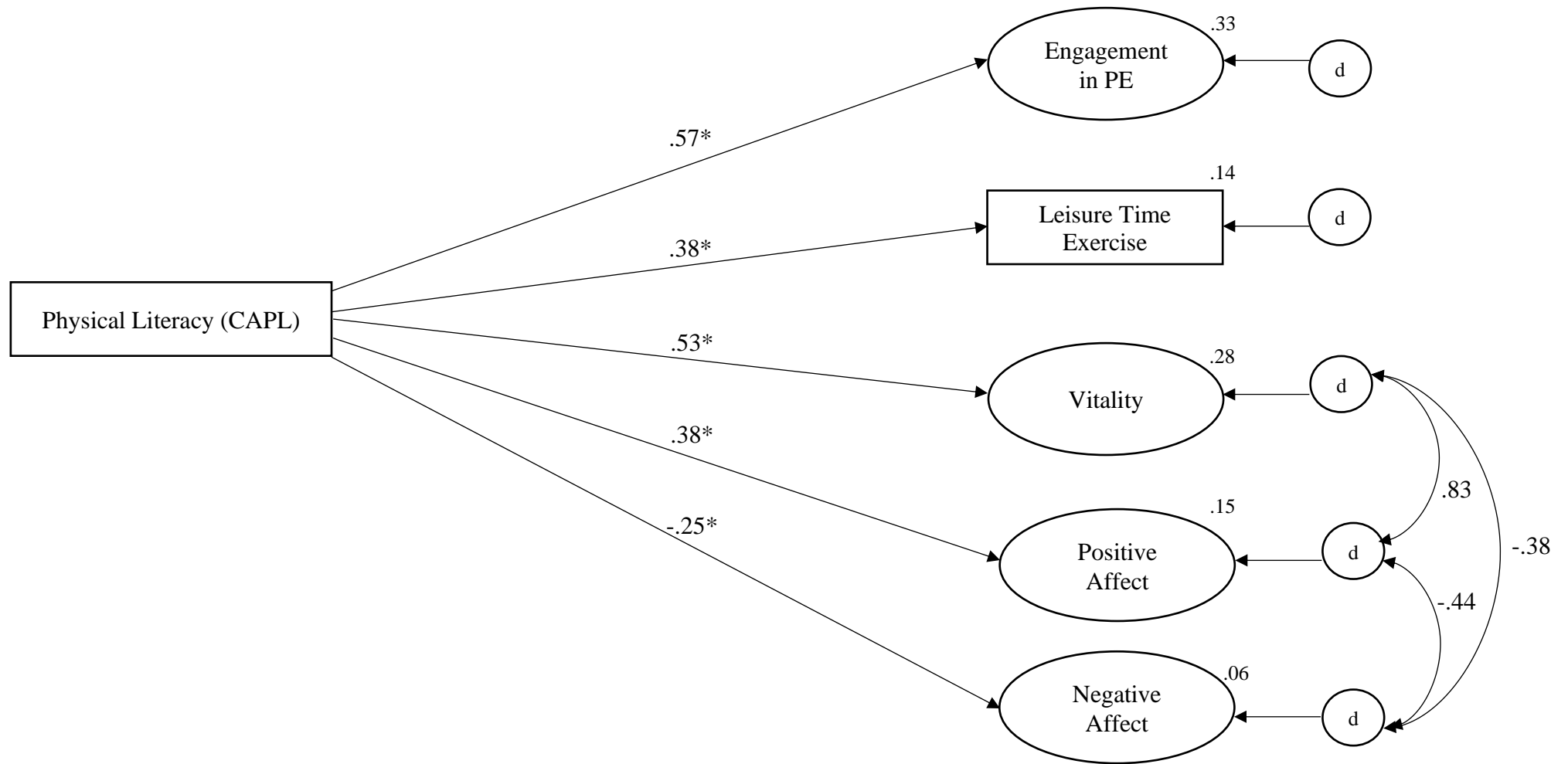


Figure 1: Structural equation model of relationships between physical literacy and outcome variables

*. Denotes statistically significant path