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Original Article

Measuring physical literacy and its association with interscholastic sports intention in sixth-grade physical education students

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Abstract
SHAPE America's national standards indicate the path to physical literacy functions as the means by which physical education (PE) students gain the ability, confidence, and desire to be physically active (SHAPE America, 2015). **Problem statement**: Given definitions of physical literacy vary, the measurement tools of physical literacy, though limited, also vary. The purpose of this study was to test the psychometric properties of proposed models of physical literacy, examine correlates of physical literacy, and investigate the significance of the relationship between physical literacy and intention to participate in physical activity in the future (i.e., interscholastic sports). **Methods**: Participants were 400 (231 female, 169 male) sixth-grade PE students who completed assessments of maturation, self-efficacy, motivation, self-esteem, knowledge and understanding, physical activity, sport participation, and interscholastic sport intention. In addition, students completed a health-related physical fitness test, an overhand throwing skill assessment, and a sedentary behavior log. Structural equation modeling was used to test the model fit of proposed measurement models of physical literacy and explore correlates of physical literacy. **Results**: Analyses offered overall support for the proposed physical literacy measurement models. Construct validity was further demonstrated by statistically significant positive associations with physical activity and sport team participation, and statistically significant negative association with screen-time sedentary behavior. In addition, results revealed a statistically significant positive path between physical literacy and interscholastic sport intention. **Discussion**: The implications of promoting physical literacy within PE are discussed in light of the three higher-order underlying factors of physical literacy. Further evidence of validity and application to PE curriculum is warranted.
Key words: **overhand throwing; physical fitness; self-efficacy; motivation**

Introduction

Physical literacy, which was first conceptualized by Margret Whitehead in 1993, has gained increased interest among educational organizations and researchers, especially in Great Britain, Australia, and Canada (Edwards et al., 2017; Mandigo et al., 2012; Whitehead, 2010). Though the physical literacy movement in the USA has lagged behind that of other countries, the 2014 National Standards & Grade-Level Outcomes for K-12 Physical Education (PE) offered by the Society of Health and Physical Educators (SHAPE America) replaced the term *physically educated person* with *physically literate individual* (Mandigo et al., 2012). This key change incorporated physical literacy as a goal of PE in the USA (SHAPE America, 2015). In their systematic literature review of the definitions, foundations, and associations of physical literacy, Edwards and colleagues (2017) indicated most definitions used in the literature contain a theme that projects lifelong participation in physical activity as the product of physical literacy. For instance, the Aspen Institute (2015) define physical literacy as "…the ability, confidence, and desire to be physically active for life" (p. 9). On the other hand, Edwards and colleagues (2017) stressed that definitions of physical literacy in extant literature often vary in that they adopt differing underlying factors and/or forego mentioning the lifelong physical activity objective. The inconsistency in defining physical literacy has lead researchers, educational organizations, and governments to interpret findings and promote interventions differently, which undermines physical literacy measurement and hinders the generalizability of research evidence (Edwards et al., 2017).

Whitehead (2010) asserted a physical literacy definition should encompass the three characteristics of human nature (i.e., affective, physical, and cognitive). She offered, "As appropriate to each individual's endowment, physical literacy can be described as the motivation, confidence, physical competence, knowledge and understanding to maintain physical activity throughout the lifecourse" (p. 11-12). Further, Whitehead (2013) defined *physical illiteracy* as avoiding any involvement or no motivation toward physical activity, no confidence in physical activity ability, very low self-esteem in the field of physical activity, and no development of physical competence. These detailed definitions highlight the individuality of physical literacy, posit physical literacy has affective, physical, and cognitive underlying factors, and hold that physical literacy is directly related to maintaining a physically active lifestyle. The definition adopted by SHAPE America ("…the ability to move

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with competence and confidence in a wide variety of physical activities in multiple environments that benefit the healthy development of the whole person" [SHAPE America, 2015]) seems to overlook affective factors and neglects to mention the lifelong objective. However, SHAPE America's national standards do project that the path to physical literacy functions as the means by which PE students gain the ability, confidence, and desire to be physically active for life (SHAPE America, 2015). On the other hand, their adopted definition suggests the physical literacy journey must encompass attaining the confidence and competence in numerous physical activities in multiple environments. This seemingly contradicts that each individual's physical literacy journey is unique and can be "…capitalized on the individual potential to take part in whatever physical activity is within an individual's capacity" (Whitehead, 2013, p. 31). That is, the SHAPE America definition seems to overlook that attaining the confidence and competence in specific physical activities may also lead to lifelong participation. For instance, an avid marathon runner or lifelong tennis player would likely be viewed as physically literate in that they possess the ability, confidence, and desire to participate in their respected activity for life. Understanding the breadth of the potential health-benefits regular lifelong physical activity affords, properly defining and promoting a concept that purportedly leads to lifelong participation (i.e., physical literacy) is crucially important. Therefore, we propose physical literacy be defined as the self-efficacy (confidence), motivation, self-esteem, physical ability, and knowledge and understanding to maintain and purposefully seek physical activity throughout life.

Measuring physical literacy

As current definitions vary, physical literacy measurement tools available, though limited, also vary. The Canadian Assessment of Physical Literacy (CAPL; Healthy Active Living and Obesity Research Group [HALORG], 2017), which adopts Whitehead's definition, produces a physical literacy measurement (score) by summing the weighted scores of four higher-order factors (i.e., physical competence factor, 30%; daily behavior factor, 30%; knowledge and understanding factor, 10%; and motivation and confidence factor, 30%). However, Tremblay and Lloyd (2010) proposed a four factor/domain physical literacy measurement model that is comprised of physical fitness, motor behavior, physical activity behaviors, and psycho-social/cognitive factors. In comparison, their model separates the physical competence factor of CAPL into two distinct factors (i.e., physical fitness and motor behavior) and combines the knowledge/understanding and motivation/confidence into a single factor. While both measurement tools include affective, physical, and cognitive factors, they also include daily activity behavior as a fourth factor of physical literacy; however, we view this as conceptually flawed. Whitehead (2013) aimed to clarify some of the misconceptions regarding physical literacy. In her report, she highlighted the importance of recognizing the relationship between physical literacy and physical activity. While the two concepts are undeniably related, she stated that, no extrinsic justifications for physical activity are needed, in that "Physical activity should be seen as an end in itself rather than a means to other ends (physical literacy)" (Whitehead, 2013, p. 33). As such, physical literacy theoretically provides the efficacy to overcome barriers of physical activity, the motivation to regularly participate, and the competence to open more avenues by which to be physically active.

In order for PE to effectively utilize physical literacy as a goal or standard, a valid assessment of physical literacy is needed (Aspen Institute, 2015a; Edwards et al., 2017; Tremblay & Lloyd, 2010). While current measurement tools are viable options, we purport the fixed-weights given to the factors in the CAPL conceptually limit the individual uniqueness of physical literacy (Whitehead, 2010, 2013), and the inclusion of daily activity behavior as a factor of physical literacy is conceptually unwarranted. Based on Edwards and colleagues (2017) and Whitehead (2010), we propose physical literacy is comprised of three primary components: affective factors (e.g., self-efficacy, motivation, and self-esteem), physical factors (e.g., physical fitness and motor skill competence), and cognitive factors (e.g., knowledge and understanding). Furthermore, this proposed three higher-order factor model effectively represent the three domains of learning (i.e. affective, psychomotor, and cognitive), which provides further theoretical support for physical literacy as an educational paradigm. Therefore, the main purpose of our study was to, first, analyze and evaluate the perspective affective (i.e., physical self-efficacy, motivation, and self-esteem), physical (i.e., physical fitness and motor skill competence), and cognitive (i.e., knowledge and understanding) factors of physical literacy. Second, we aimed to test the model fit of underlying factor models and the proposed physical literacy models (see Figure 1), whilst exploring measurement invariance with respect to sex. Third, we aimed to examine the relationships between physical literacy and proposed correlates (i.e., physical activity, sport participation, and screen-time sedentary behavior). Fourth, we aimed to investigate proposed physical literacy models' relationship with sixth-grade students' intention to participate in interscholastic sports in that participating in interscholastic sports is optional. Thus, accurately reflecting "purposeful physical pursuits/activities," which Whitehead (2013) holds as a key vehicle and goal of physical literacy (p. 29).

To extend on literature reviewed, it was first hypothesized physical literacy would significantly explain the variance of the affective, physical, and cognitive factors (Edwards et al., 2017). Second, given Whitehead (2010) holds that each individual's physical literacy journey is appropriately unique and sex/gender differences in many of the underlying factors have been previously measured (Gromeier et al., 2017; Longmuir et al., 2015; Raghuveer et al., 2020), it was hypothesized the proposed models would demonstrate variance across sex. Third, it was hypothesized physical activity and sport participation would be significantly positively related and screen-time sedentary behavior would be significantly negatively related to the physical literacy construct (Edwards et al., 2017; Longmuir et al., 2015). Lastly, it was hypothesized higher levels of the affective, physical, and cognitive factors, thereby, higher levels of physical literacy would be significantly positively related to interscholastic sports intention (Edwards et al., 2017; Whitehead, 2010).

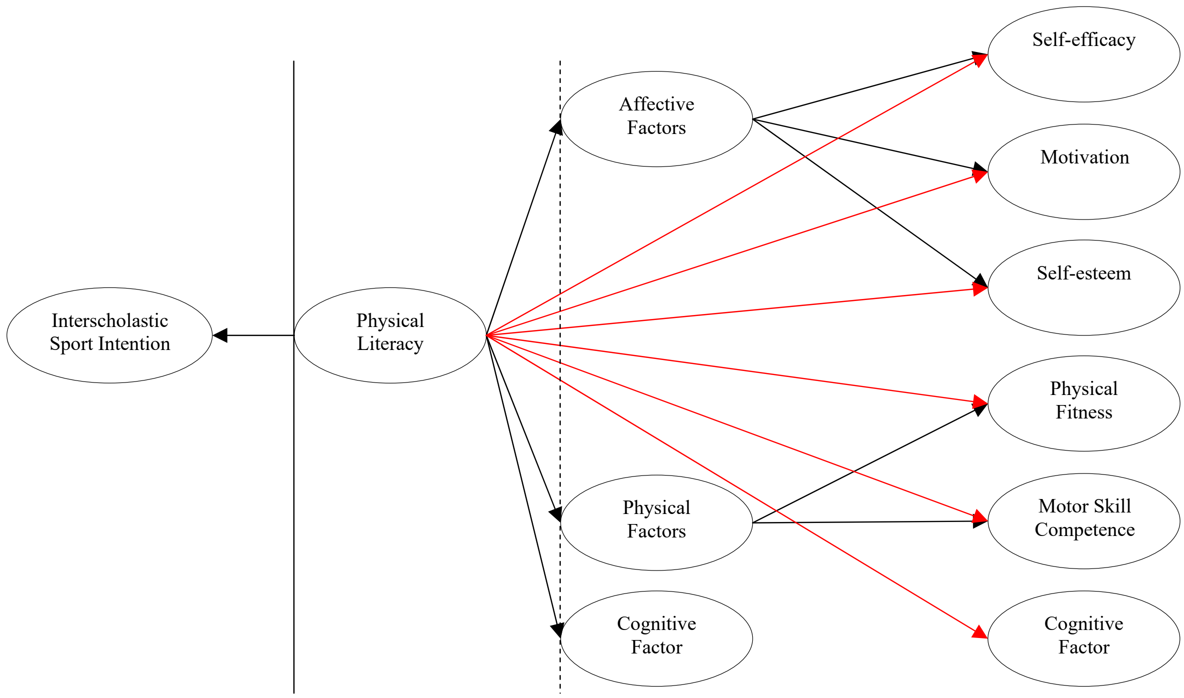

Fig.1. Hypothesized first-order (red arrows) and second-order (black arrows) physical literacy measurement model illustrating its relationship with interscholastic sport intention. Right of the dashed vertical line represents the measurement models of the underlying factors of physical literacy, while right of the solid vertical line represents the physical literacy measurement models. Left of the solid vertical line represents the intention measurement model.

Material & methods

Participants

Participants were 419 sixth-grade PE students (244 female, 175 male; M_{age} = 11.51 years, *SD* = 0.5, range = 11-12 years) from two public middle schools (School A = 276, School B = 143) located in the Southwest USA. Participants were predominately white (74.5%), followed by multi-racial/other (15.0%), Hispanic/Latino (6.2%), Black/African-American (2.9%), and Asian (1.4%). Schools were located in middle-class to upper-middle-class suburban neighborhoods.

Procedures

Researchers' Institutional Review Board approved the study, and parents and participants provided written informed consent and assent, respectively. Cross-sectional research design was used to collect data. Data collection consisted of three brief surveys, a motor skill assessment, physical fitness assessments, and a sedentary behavior log. All data were collected during participants' regularly scheduled PE class. Each survey was completed within a single PE class. Survey 1 assessed basic demographics (i.e., age, date of birth, sex, and ethnicity) and knowledge and understanding about physical literacy. Survey 2 assessed physical activity, sport team participation, global self-esteem, and PE self-efficacy, and Survey 3 assessed intrinsic motivation and interscholastic sports intention. The motor skill assessment, physical fitness assessments, and the sedentary behavior log were each completed within one school week. As compensation for participation, all participants received a water bottle and were entered into a lottery to win an iPad Mini.

Measures & instruments

PE self-efficacy. Understanding self-efficacy as situationally specific confidence, participants' PE confidence was assessed using a 6-item PE self-efficacy questionnaire (Gao et al., 2008). All items contained the stem, "With regard to the activities in my PE class, I have confidence in:" Example item for confidence scale was "My ability to do well in most activities." Participants were asked to indicate how strongly they agreed or disagreed with each item on a 7-point scale, ranging from 1 (*strongly disagree*) to 7 (*strongly agree*), regarding their confidence in PE activities. Self-efficacy scores in the current study demonstrated high internal consistency (α = .93).

Intrinsic motivation. Participants' intrinsic motivation toward PE was assessed using the 4-item intrinsic motivation subscale of the 20-item Perceived Locus of Causality scale (Ryan & Connell, 1989). All items contained the stem, "I take part in this PE class…" Example item was "because PE is fun." Participants were asked to indicate, on a 7-point scale ranging from 1 (*strongly disagree*) to 7 (*strongly agree*), the extent to which they agreed or disagreed with each item. This subscale has been validated in an adolescent PE setting (Standage et al., 2005). Scale scores in the present demonstrated good internal consistency ($\alpha = .87$).

Self-esteem. Global self-esteem was assessed using the 6-item Global Self-esteem Scale (GSES) of the Self-perceptions Profile for Children questionnaire (Harter, 2012). Participants were asked to indicate how true each structured alternative format item was, on a 2×2-point scale ranging from 1 (*really true for me*) to 2 (*sort of true for me*) in the low self-esteem format to 3 (*really true for me*) to 4 (*sort of true for me*) in the high self-esteem format. In the current study, scores for the global self-esteem had good internal consistency ($\alpha = .83$).

Physical fitness. FITNESSGRAM® test items (The Cooper Institute, 2013) and the NHANES (2012) plank test were used to assess participants' physical fitness. Specifically, body composition and aerobic capacity/fitness were assessed using the body mass index (BMI) measure and the Progressive Aerobic Cardiovascular Endurance Run (PACER) from the FITNESSGRAM®, respectively, and the NHANES (2012) plank test was used to assess muscular fitness. BMI, PACER, and plank tests are utilized in the CAPL (HALORG, 2013; Longmuir et al., 2015) to measure the physical capability factor of physical literacy.

BMI. A Health-o-meter® 500KL digital physician height/weight scale (Pelstar, LLC, St. McCook, IL) was used to measure participants' height and weight to compute BMI. As a measure of body composition, BMI is an indication of the healthy weight to height ratio in that a high BMI can indicate high body fatness, while a low BMI can indicate low body fatness. To gain more precise measurements, participants removed their shoes when measuring height (to the nearest quarter inch) and weight (to the nearest tenth pound).

Aerobic fitness. The objective of the PACER is to run 20-meter laps as long as possible at a specified pace that has a progressive intensity (The Cooper Institute, 2013). Thus, the more laps completed constitutes a higher level of aerobic fitness. Common errors such as not completing a lap within the given time and beginning a lap before the signifying beep were demonstrated by the researchers to improve the participants' understanding of what should be avoided. Participants' PACER was completed when they could no longer continue or after they committed a second error. Participants' total number of correctly completed laps was then used to compute an estimate of their aerobic capacity (i.e., VO_2max) using the quadratic formula developed by Mahar and colleagues (2011).

Plank test. The objective of the plank test (NHANES, 2012) was to hold the plank position for as long as possible with a maximum of 300 seconds. An audio track containing a second count-off was used to signify the number of seconds held in the plank position. Proper position and common errors such as a dip in the back and legs and the buttocks being extended higher in the air were demonstrated by the researchers. Participants' plank test was completed when they could no longer continue or after they committed a second form error. The number of seconds plank position was held was the participants' performance score.

Motor skill competence. Participants' motor skill competence, specifically, overhand throwing competence was assessed using the fifth grade PE Metrics® rubric (SHAPE America, 2010). Overhand throwing competence (OTC) was chosen as the measure of motor skill competence because previous research suggested OTC was the most difficult motor skill and proficiency in object control skills like throwing significantly predicted physical activity in future years (Barnett et al., 2009). PE Metrics® overhand throwing rubric consists of assessing participants' performance level in both *form* and *accuracy* of throwing to a target using a 0–4 rating scale on three attempts. OTC performance scores could range from 0 to 12 for each component (i.e., form and accuracy) or 0 to 24 total. The PE Metrics® rubric indicated a total score of 18 or higher signified competence. Two trained field staff scored each component simultaneously using the record sheet provided in the rubric (SHAPE America, 2010). Field staff reached an interrater agreement of greater than 90% in pilot testing and in the current study. To provide an addition measure of motor skill competence, participants' average throwing speed in miles per hour (Speed) was assessed using a Bushnell® Velocity Speed gun (Bushnell Outdoor Products, Overland Park, KS). Previous research indicated Speed was significantly correlated with OTC (Roberton & Konczak, 2001).

Knowledge and understanding. Participants' knowledge and understanding of concepts related to PE and physical activity was assessed using the 10-item measure of the CAPL questionnaire, which were developed to reflect curricula of PE in grades 4, 5, and 6 (HALORG, 2013; Longmuir et al., 2015). Specifically, items assessed: (a) participants' understanding of minimal physical activity and maximum sedentary behavior guidelines; (b) awareness of fitness, activity, and motor skill parameters, as well as proper methods of improving activity and fitness levels and motor skill competence; (c) perceptions of health; and (d) proper use of safety equipment commonly used when performing physical activities (Longmuir et al., 2015). Per the CAPL scoring guidelines, seven items were dichotomously scored, 0 (*incorrect*) and 1 (*correct*); two items were scored on 6-point scale ranging from 0 (*zero correct responses*) to 5 (*all correct responses*); and one item was scored based on the percentage of the 11 safety scenarios that were correctly assessed ranging from 0 (*zero percent*) to 1 (*100 percent*). Thus, total scores could range from 0 to 18. Previous research indicated scores were independent of participants' sex and were directly related to participants' age (Longmuir et al., 2015).

Physical activity and sport team participation. Physical activity and sport team participation were assessed using two items from the Middle School Youth Risk Behavior Surveillance Survey (MSYRBS; (Centers for Disease Control and Prevention, 2016). Specifically, one item assessed physical activity (i.e., Days60, indicate how many days of the last seven day were you physically active for a total of at least 60 minutes per day), and one item assessed sport team participation (i.e., STP, indicate on how many sports teams did you play during the past 12 months). As such, participants' Days60 ranged from 0 to 7 days, and participants' STP ranged from 0 (*zero teams*) to 3 (*three or more teams*).

Sedentary behavior. The Adolescent Sedentary Activity Questionnaire (ASAQ; (Hardy et al., 2007) was used to assess students' sedentary activities. To limit memory or recall errors students were asked to log their activity daily instead of asking them to recall activity from the previous seven days. Example of sedentary behavior activities logged were "Watching TV or Videos" and "Doing homework not on a computer." For analyses, screen-time sedentary behavior (STSB) and non-screen-time sedentary behavior (NSTSB) were summed separately in that STSB is considered a health-risk behavior (González et al., 2017).

Interscholastic sport intention. Based on previous validated activity intention scales (Alvarez et al., 2012), four items were created to assess students' interscholastic sport intention (i.e., play interscholastic or school sports) in the seventh grade. Specifically, students were asked to respond to "I plan to enroll in athletics (play school sports) next school year," "I intend to play school sports next year," "I am determined to play school sports next year," and "I am looking forward to playing school sports next year," on a 5-point scale ranging from 1 (*strongly disagree*) to 5 (*strongly agree*), the extent to which they agreed or disagreed with each item. Scores for the interscholastic sport intention items demonstrated high internal consistency ($\alpha = .97$).

Statistical analyses

Statistical analyses were conducted using SPSS® 22.0 (IBM Corporation, Armonk, NY, USA) for Windows®/Apple Mac® and Version 7.3 of M*plus*. Statistical significance was set at $\alpha < .05$. Before testing model fit and aforementioned hypotheses, missing values, univariate normality, and univariate and multivariate outliers were explored. Missing data analysis revealed no data were missing. All variables were deemed normally distributed except BMI (skewness = 1.64, *SE* = .12; kurtosis = 3.49, *SE* = .24). Previous research indicates BMI tends to be positively skewed in the tested age group (Rothman, 2008). Overall, 19 participants had univariate or multivariate outliers (Kannan & Manoj, 2015). After removing outliers, score reliabilities, descriptive statistics, and the inter-observer agreements for the OTC scores were assessed.

Structural equation modeling (SEM) using maximum likelihood estimation was used to explore measurement invariance (Brown, 2015; Kline, 2016), test model fit of the measurement models, examine relationships among physical literacy factors, and test the proposed structural model investigating the directional relationship between physical literacy and interscholastic sports intention. Specifically, confirmatory factor analyses (CFA) were used to assess the model fit of each measurement model (underlying and higher-order factor measurement models) in order to examine their ability to accurately represent (i.e., model fit) the observed data (Brown, 2015). Specifically, underlying factor measurement models tested were: (a) PE self-efficacy; (b) intrinsic motivation; (c) self-esteem; (d) physical fitness (i.e., BMI, VO_2max, and plank); (e) motor skill competence (i.e., OTC and Speed); and (f) interscholastic sport intention. Higher-order factor measurement models tested were: (g) affective factor; (h) physical factor; and (i) the proposed first- and second-order physical literacy factor (see Figure 1). Regarding invariance testing, models were tested for equality of constraints across sex using multi-sample invariance analyses (Brown, 2015; Kline, 2016). After measurement model fits were tested, further construct validity was assessed by examining the relationships between the physical literacy factor scores and Days60, STP, and STSB. Lastly, SEM analyses were conducted to investigate the relationship between sixth-grade PE students' physical literacy and their interscholastic sports intention for the seventh grade.

In the SEM analyses, factors represented by a single item (i.e., knowledge and understanding), as well as motor skill competence variables (i.e., OTC and Speed) and physical fitness variables (i.e., BMI, VO_2max, and plank) were standardized (*Z*-score), so that all variables were on a similar metric, facilitating maximum likelihood estimates (Brown, 2015). In addition, factors represented by a single item had their path coefficient fixed to a nonzero value (1) and their residual variance fixed to zero (Brown, 2015). The chi-square statistic (χ^2) can be problematic due to its sensitivity to sample size and the number of indicators and/or factors in the model (Hooper et al., 2008), therefore, model fit was assessed using multiple fit indices (i.e., root mean square error of approximation [RMSEA], standardized root mean square [SRMR], comparative fit index [CFI], Tucker-Lewis index [TLI], Bayesian information criterion [BIC], and sample-size adjusted BIC [SABIC]). For RMSEA and SRMR values less than or equal to .05 indicate excellent fit and values between .06 and .10 respectively indicate good to mediocre fit (Hooper et al., 2008). For CFI and TLI, which generally perform well with a small sample size, values greater than or equal to .96 indicate excellent fit and values between .95 to .90 indicate good to mediocre fit, respectively (Hooper et al., 2008; Hu & Bentler, 1999). For BIC and SABIC, which are used to judge the better fitting model, the lower value indicated a better model fit (Kline, 2016). In addition, average variance extracted (*AVE*) by factor and composite reliabilities (*CR*) were calculated (Kline, 2016).

Results

Descriptive statistics

Descriptive statistics for fitness variables revealed mean performances for both sexes were considered healthy or favorable. That is, 80.5% of females and 71.0% of males had a BMI in the healthy fitness zone (HFZ) or the very lean zone, 59.3% of females and 74.6% of males had a VO_2max estimation score in the HFZ, and 56.7% of females and 74.5% of males had a plank time that was categorized as *achieving* or *excelling* (HALORG, 2017; The Cooper Institute, 2013). Further, descriptive statistics indicated mean OTC score for females was 16.37 (*SD* = 1.26) with only 8.7% categorized as competent and mean OTC score for males was 18.63 (*SD* = 1.22) with 78.7% categorized as competent. Mean Speed was 36.21 kph (*SD* = 4.52) for females and 49.52 kph (*SD* = 5.41) for males. Descriptive statistics for the knowledge and understanding measure indicated the majority of participants (87.9% of females and 91.1% of males) were categorized as *progressing* or *achieving* (HALORG, 2013). Lastly, descriptive statistics for the proposed correlates of physical literacy indicated, in females, only 32.5% engaged in at least 60 minutes of MVPA on five or more days each week (Days60), whereas, a significantly larger percentage of males did (55.6%). Further, 73.2% of females and 71.6% of males reported they had participated in at least one sport team in the last 12 months (STP), and, on average, females logged 163.27 minutes (*SD* = 55.86) and males logged 153.70 minutes (*SD* = 64.69) of STSB per day.

Invariance and CFAs

Results of the measurement invariance tests indicated affective factor models were invariant; however, physical factor models and interscholastic sport intention model, and thereby physical literacy models were found to be variant. That is, intercepts differed (i.e., were variant) between sexes in the physical fitness and interscholastic sport intention models, and factor loadings (path coefficients) and intercepts differed in the motor skill competence model. As expected, this variance resulted in physical literacy models that were variant. Based on these findings, further tests for weak and strong invariance were inappropriate. Therefore, separate models were constructed for females and males.

Results of the tested models are presented in Table 1. Slight modifications of the tested models were performed to improve model fit (Brown, 2015; Kline, 2016). Specifically, one item from the self-efficacy scale and one item from the self-esteem scale were removed from both female and male models, in that modification indices suggested their removal would improve model fit (Brown, 2015). Further, based on the recommendations of Muthén & Muthén (www.statmodel.com), items or factors with non-statistically significant negative residual variances had their residual variances fixed to zero in order to avoid a not positive definite residual covariance matrix. Finally, modification indices suggested the residual variances for BMI and plank variables be correlated to improve model fit (Rothman, 2008).

Table 1. *Results of the Confirmatory Factor Analyses (Measurement Models) by Sex*

	χ^2	*df*	*p*-value	CFI	TLI	SRMR	RMSEA (90% CI)	BIC
Females								
Physical Self-efficacy	25.08	5	.00	.98	.96	.03	.13 (.08 - .19)	3291.75
Intrinsic Motivation	2.99	2	.22	1.00	.99	.01	.05 (.00 - .15)	3264.71
Self-esteem	3.80	5	.58	1.00	1.01	.02	.00 (.00 - .08)	2578.44
Affective Factor	102.94	74	.01	.98	.98	.04	.04 (.02 - .06)	9095.87
Fitness*	0.00	0	.00	1.00	1.00	.00	.00 (.00 - .00)	1681.69
Motor Skill*	0.00	0	.00	1.00	1.00	.00	.00 (.00 - .00)	855.14
Physical Factor	4.08	5	.54	1.00	1.00	.02	.00 (.00 - .08)	2481.01
Knowledge and Understanding*	0.00	0	.00	.00	1.00	.00	.00 (.00 - .00)	677.29
FO Physical Literacy	223.52	164	.00	.97	.97	.06	.04 (.03 - .05)	12121.66
SO Physical Literacy	221.45	163	.00	.97	.97	.06	.04 (.03 - .05)	12125.03
Males								
Physical Self-efficacy	13.08	5	.02	.99	.97	.02	.10 (.04 - .16)	2478.56
Intrinsic Motivation	0.97	2	.62	1.00	1.01	.01	.00 (.00 - .12)	2485.37
Self-esteem	6.11	5	.30	1.00	.99	.03	.04 (.00 - .12)	1811.76
Affective Factor	91.19	74	.08	.99	.98	.05	.04 (.00 - .06)	6764.20
Fitness*	0.00	0	.00	1.00	1.00	.00	.00 (.00 - .00)	1188.20
Motor Skill*	0.00	0	.00	1.00	1.00	.00	.00 (.00 - .00)	647.84
Physical Factor	4.79	5	.44	1.00	1.00	.03	.00 (.00 - .11)	1717.12
Knowledge and Understanding*	0.00	0	.00	.00	1.00	.00	.00 (.00 - .00)	473.52
FO Physical Literacy	245.32	166	.00	.96	.95	.07	.05 (.04 - .07)	8880.85
SO Physical Literacy	226.44	165	.00	.97	.96	.06	.05 (.03 - .06)	8867.10

Note. Females (*n* = 231), Males (*n* = 169). *df* = degrees of freedom; CFI = comparative fit index; TLI = Tucker-Lewis index; BIC = Bayesian information criterion; SRMR = standardized root mean square; RMSEA = root mean square error of approximation; CI = confidence interval; FO = first-order; SO = second-order.
*Just-identified models.

Table 2. *Standardized Path Coefficients, Variance Explained (R^2), Average Variance Explained (AVE), and Alpha (α) and Composite Reliabilities (CR) of the Physical Literacy Models by Sex*

	Path Coefficients		R^2		*p*-value				
Factors and Items	FO	SO	FO	SO	FO	SO	AVE	α	*CR*
Female (*n* = 231)									
FO Physical Literacy							.86	—	.76
SO Physical Literacy							.94	—	.86
Self-efficacy	.69	.75	.48	.56	.00	.00	.97	.92	.92
Motivation	.28	.33	.08	.11	.06	.04	.96	.88	.88
Self-esteem	.58	.59	.34	.34	.00	.00	.88	.75	.75
Physical Fitness	.86	.87	.73	.87	.00	.00	.94	.78	.83
Motor Skill Competence	.63	.62	.39	.62	.00	.00	.90	.69	.73
Knowledge & Understanding	.48	.48	.23	.23	.00	.00	—	—	—
Affective Factor	—	.90	—	.81	.00	.00	.83	—	.58
Physical Factor	—	1.00	—	1.00	.00	.00	.90	—	.72
Male (*n* = 169)									
FO Physical Literacy							.86	—	.81
SO Physical Literacy							.93		.81
Self-efficacy	.52**	.63*	.27	.39	.00	.00	.96	.91	.91
Motivation	.34	.40	.12	.16	.04	.02	.93	.85	.85
Self-esteem	.40*	.51	.16	.26	.01	.00	.89	.79	.80
Physical Fitness	.89	.95**	.80	.89	.00	.00	.97	.84	.87
Motor Skill Competence	.79**	.76**	.62	.58	.00	.00	.97	.78	.82
Knowledge & Understanding	.52	.67**	.27	.45	.00	.00	—	—	—
Affective Factor	—	1.00**	—	1.00	.00	.00	.77	—	.52
Physical Factor	—	.73**	—	.53	.00	.00	.93	—	.85

Note. FO = first-order; SO = second-order.
*$p < .05$, **$p < .01$ (statistically significant variance between sexes).

The first-order physical literacy model (as illustrated in Figure 1) demonstrated weak evidence for the better fitting model in females (ΔBIC = 3.37); whereas, the second-order physical literacy model demonstrated positive evidence for the better fitting model in males (ΔBIC = 13.75). However, given ΔBIC values were minimal and model selection decisions based on single fit index have a greater likelihood of Type I and II errors (Hooper et al., 2008; Hu & Bentler, 1999; Kline, 2016) both first- and second-order models were further tested. Table 2 presents the factor loadings, variance explained (R^2), average variance explained (AVE), and alpha (α) and composite reliabilities (*CR*) of the first- and second-order physical literacy models. Factor loadings and R^2 values revealed all loadings were statistically significant and all factors were able to significantly reproduce the variances of the indicator variables and the lower-order factors. Collectively, the results of the CFAs indicated the first- and second-order physical literacy model fit the data well and demonstrated good reliability (Kline, 2016).

Correlates of physical literacy

The estimated correlation matrix of the physical literacy models and the measured correlates by sex is presented in Table 3. Among both female and male participants, coefficients between the physical literacy factors and Days60, STP, and STSB revealed physical literacy was statistically significantly related to Days60, STP, and STSB. Specifically, physical literacy, on average, shared approximately 35-36% variance with Days60, 18% with STP, and 4-5% with STSB in females, and 37-45% with Days60, 24-30% with STP, and 4-5% with STSB in males.

Table 3. *Estimated Correlation Matrix for the Physical Literacy Models and the Measured Correlates by Sex*

Latent Variables	1.	2.	3.	4.	5.	6.
1. FO Physical Literacy Factor	—	.90**	.61**	.49**	-.19*	-.09
2. SO Physical Literacy Factor	1.00**	—	.67**	.55**	-.22**	-.03
3. Physical Activity (Days60)	.60**	.59**	—	.42**	-.36**	-.05
4. Sport Team Participation (STP)	.42**	.42**	.37	—	-.08	-.02
5. STSB	-.22**	-.21**	-.24	.08	—	.76**
6. NSTSB	.05	.04	-.02	.06	.73**	—

Note. Lower diagonal represents female data (*n* = 231), and upper diagonal represents male data (*n* = 169). FO = first-order; SO = second-order; STSB = screen-time sedentary behavior; NSTSB = non-screen-time sedentary behavior.
*$p < .05$, **$p < .01$.

Interscholastic sport intention and physical literacy

The goodness-of-fit indices for the proposed interscholastic sports intention model derived from the CFA using female data were: χ^2 (2) = 1.00, *p* = .61; RMSEA = .00 (CI = .00 – .11); SRMR = .00; CFI = 1.00; and TLI = 1.00; and using male data were: χ^2 (2) = 3.93, *p* = .14; RMSEA = .08 (CI = .00 – .18) ; SRMR = .00; CFI = 1.00; and TLI = .99. As expected, given the near perfect fit, factor loadings and R^2 values revealed all loadings were statistically significant and the interscholastic sports intention factor significantly reproduced the variances of the indicator variables. Collectively, these results indicated the proposed interscholastic sports intention model demonstrated exceptional model fit for both sexes (Hooper et al., 2008; Hu & Bentler, 1999; Kline, 2016).

Table 4. *Results of the SEM Investigating the Relationship between Physical Literacy and Interscholastic Sport Intention by Sex*

	χ^2	*df*	*p*-value	CFI	TLI	SRMR	RMSEA (90% CI)	BIC
Females (*n* = 231)								
Intention on Physical Literacy Factors	281.44	232	.01	.99	.98	.05	.03 (.01 - .04)	14100.55
Intention on FO Physical Literacy	335.34	245	.00	.98	.97	.06	.04 (.03 - .05)	14083.69
Intention on SO Physical Literacy	326.48	244	.00	.98	.98	.06	.04 (.03 - .05)	14080.27
Males (*n* = 169)								
Intention on Physical Literacy Factors	316.02	233	.00	.97	.97	.05	.05 (.03 - .06)	10378.24
Intention on FO Physical Literacy	382.86	246	.00	.95	.95	.06	.06 (.05 - .07)	10378.39
Intention on SO Physical Literacy	328.29	246	.00	.97	.97	.06	.04 (.03 - .06)	10323.82

Note. FO = first-order; SO = second-order.

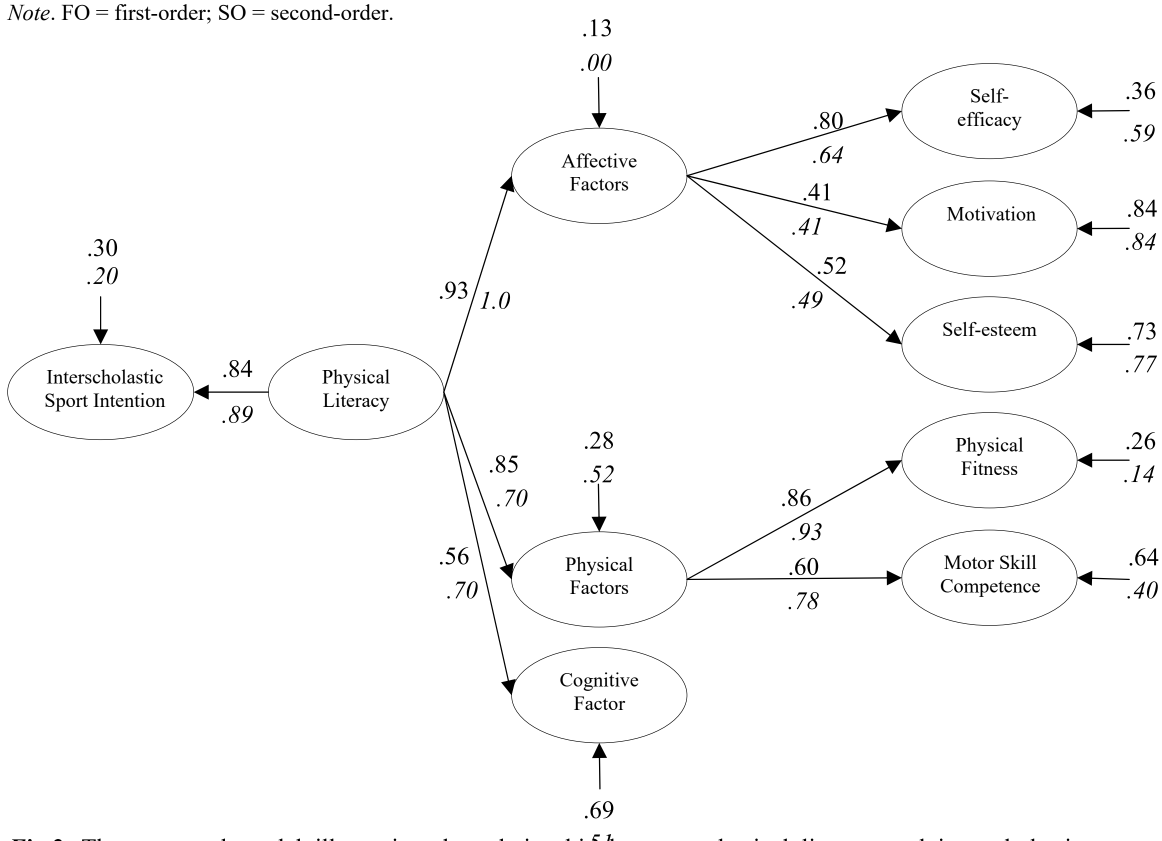

Fig.2. The structural model illustrating the relationship between physical literacy and interscholastic sport intention with the standardize estimates for factor structure path coefficients and the factor residual variances labeled (italicized coefficients and residual variances represent male data).

Results of the SEM analyses investigating the relationship between the physical literacy construct and interscholastic sport intention by sex are presented in Table 4. Based on comparative fit indices, the SEM analyses indicated the second-order physical literacy model demonstrated weak to strong evidence for the better fitting structural model in females (ΔBIC = 3.42) and in males (ΔBIC = 54.57). These results build up our previous results, and provide further evidence for adopting a second-order physical literacy model. However, limitations of selecting a better model based on a single fit index still apply. As shown in Table 4, the goodness-of-fit indices for the second-order physical literacy structural model predicting interscholastic sport intention demonstrated the implied covariance matrix adequately represented the observed covariance matrix in both female and male sixth-grade PE students. An examination of the path coefficients and R^2 values revealed that in both models (female and male) all paths were statistically significant and all factors were, again, able to significantly reproduce the variances of the observed variables. Graphic illustrations of the second-order physical literacy structural model predicting interscholastic sport intention, including standardized path coefficients are presented in Figure 2. For females, the physical literacy factor was statistically significantly associated to the interscholastic sport intention factor ($\gamma = .84$, $p < .001$), which indicated, on average, physical literacy explained approximately 70% of the variance in interscholastic sport intention. For males, the physical literacy factor, again, was statistically significantly associated to the interscholastic sport intention factor ($\gamma = .89$, $p < .001$), which indicated, on average, physical literacy explained approximately 80% of the variance in interscholastic sport intention.

Discussion

The proposed measurement models of physical literacy tested in the present study were developed based on the conceptualizations provided by extant literature (Aspen Institute, 2015b; Edwards et al., 2017; Whitehead, 2010). Specifically, we conceptualized physical literacy as a higher-order factor comprised of the affective (self-efficacy, motivation, self-esteem), physical (physical fitness and motor skill competence), and cognitive (knowledge and understanding) factors to maintain and purposefully seek physical activity throughout life. The present study was designed to test the psychometric properties of proposed models of physical literacy, examine correlates of the physical literacy factor, and investigate the significance of the relationship between physical literacy and interscholastic sport intention in the context of sixth-grade PE. CFAs provided validation evidence that indicated the psychometric properties of the underlying factor models and the proposed physical literacy models were sustained in the sample of sixth-grade PE students. These results supported the first hypothesis in that the physical literacy factor significantly explained variance of the affective, physical, and cognitive factors, and those underlying factors significantly explained observed variables measured. In addition, these analyses provided further construct validation of the underlying factor models (Alvarez et al., 2012; Gao et al., 2008; Harter, 2012; Longmuir et al., 2015; Ryan & Connell, 1989; Standage et al., 2005), while also providing initial construct validity for the proposed higher-order physical literacy models. Though, comparatively, the second-order model demonstrated better fit, according to the parsimony principle "…two models with similar fit to the data, the simpler model is preferred…" (Kline, 2016, p. 128). Therefore, future researchers are encouraged to use the model that best suits their question.

The exploration of variance between sexes of the proposed measurement models supported the second hypothesis. That is, measurement variance between sexes was present in both the physical fitness and motor skill competence measurement models, which thereby lead to measurement variance in the higher-order physical factor and physical literacy measurement models. Between sex variance can, in part, be explained by the relevant physiological changes that occur during early adolescence (Raghuveer et al., 2020). Subjection to sex-related social and cultural constraints regarding activity engagement norms may further explain this variance (Wright et al., 2003). Furthermore, variance between sexes supported the position that the physical literacy journey is unique to each individual (Whitehead, 2010). As displayed in Table 2, the factor structure path coefficients in the second-order physical literacy model indicated the physical factor had the highest value for females and the affective factor had the highest value for males. These results suggest, in this sample, physical factors may carry greater weight in determining physical literacy in females; whereas, affective factors may carry greater weight in determining physical literacy in males. This difference may again reflect social and cultural constraints (Wright et al., 2003), but further research is needed to determine whether this result is generalizable or particular to this sample. In addition, the present study indicated the cognitive factor had a significantly larger factor structure path coefficient in males than in females, even though Longmuir and colleagues (2015) found gender/sex was not related to the cognitive factor. On the other hand, the present study was the first to test the cognitive factor as a freely estimated underlying factor of latent higher-order physical literacy factor; therefore, this result needs to be further tested in alternate samples.

The examination of the relationships between the measured physical literacy construct and the proposed theoretically relevant variables (i.e., Days60, STP, and STSB) provided further evidence of construct validity, which supported the third hypothesis. This evidence supports Edwards and colleagues' (2017) assertion that physical literacy significantly relates to behaviors such as physical activity, sport participation, and health-risk behaviors (e.g., screen-time sedentary behavior). It also supports the notion that physical literacy is bi-directionally related to regular engagement in purposeful physical pursuits such as physical activity and sport participation (Cornish et al., 2020). Overall, the validity analyses revealed, in this sample of early adolescents, enhanced physical literacy was associated with a greater number of days per week with at least 60 minutes of physical activity, a greater number sport teams in which participated, and fewer minutes of screen-time sedentary behavior.

The SEM analyses provided additional validation evidence to support the proposed models of physical literacy in the context of sixth-grade PE. As hypothesized, participants' physical literacy was statistically significantly related to their intention to participate in interscholastic sports, which further supported the position that physical literacy is highly related to future purposeful pursuits in physical activity/sports (Edwards et al., 2017; Whitehead, 2010). When comparing factor structure path coefficients in the structural model with the factor structure path coefficients in second-order physical literacy measurement model, a few interesting differences were revealed. Specifically, in both models (female and male), the path coefficient between the physical literacy higher-order factor and the physical factor decreased, while the path coefficients between the physical literacy higher-order factor and the affective factor increased. As expected, the path coefficients between the affective factor and the self-efficacy and motivation underlying factors also increased. These findings indicate freely estimating these paths resulted in the make-up of the physical literacy factor changing in order to improve fit in the structural model. Given Whitehead (2013) stated "…the motivation and confidence to participate in physical activity are at the heart of the concept" (p. 31) and participating in interscholastic sports is an optional future behavior, this change in the make-up of physical literacy was expected. These findings also suggest that the contributions of the underlying factors in a physical literacy measure may depend greatly on the specific outcome being investigated. That is, physical factors such as aerobic capacity may be a greater contributor when current activity behavior is investigated; whereas, affect factors such as intrinsic motivation may be a greater contributor when future activity behavior and adherence is investigated. Future research is encouraged to examine the contribution of factors of physical literacy with proposed outcomes, such as academic performance, intramural and recreational activity engagement, all-cause mortality and morbidity risk factors, and long-term activity adherence. Further, future research is encouraged to examine the effects PE curriculums, such as Sport Education, Adventure Education, and Fitness and Wellness Education, have on the physical literacy and its underlying factors (Whitehead, 2013).

Limitations and strengths

Overall, the findings of the present study confirmed the research hypotheses; however, the current study had limitations to consider when interpreting results. First, all affective, cognitive, activity, and behavior intention data were collected via self-report; thus, they are subject to social desirability biases (Caputo, 2017). It should be noted that while measures were taken to reduce this limitation, such as ensuring participants did not group together while responding to the questionnaires and reminding participants all responses would remain confidential, it still remains a limitation to the current study. In addition, this study holds the assumption participants fully understood each self-reported item and that they were able to accurately recall past activity behavior. If participants responded to an item without truly understanding its objective or without being able to accurately recall particulars of past behavior, then their scores would be subject to measurement error. While researchers and their assistants were present and actively volunteered to answer clarifying questions, this limitation was still present. Second, to obtain participants' best physical performance score in the physical fitness and motor skill assessments, required participants to give maximal effort during testing. Thus, validity of participants' performance scores may have suffered if they did not or could not give best effort. Further, only select physical capabilities were assessed, thus, assessing alternate or additional capabilities such as flexibility, balance, and course agility may produce alternate results. Third, given that participants were from schools located in middle-class to upper middle-class neighborhoods, the generalizability of these findings may be limited to similar samples. Future research should test the fit of proposed models and its associations in alternative samples with lower socioeconomic status. Lastly, the cross-sectional research design employed did not allow for causal conclusions to be made; thus, result interpretations were limited to a relational nature. Future research examining the significance of physical literacy on future engagement in physical activities should employ longitudinal research design or experimental research design so that the real effect of physical literacy on future engagement can be determined.

Despite the noted limitations, the present study had several significant strengths worth stating. To our knowledge the present study was the first to test the psychometric properties of a comprehensive or multidimensional model of physical literacy. Considering physical literacy is still thought as a relatively new paradigm in PE, it "…provides a fresh springboard from which a renewed emphasis on physical education can emerge" (Tremblay & Lloyd, 2010, p. 26). However, to effectively utilize this renewed interest, educational organizations and researchers must have an agreed upon understanding of how to define and measure this complex concept. As such, the primary strength of the present study was that it provided validation for an initial multidimensional measurement model for assessing physical literacy. Future research is encouraged to further validate and/or make suggested and practical adjustments to this model to improve its validity. Second, knowing the principal objective of producing physically literate individuals is to establish a strong desire to continue to seek purposeful physical pursuits, the present study provided evidence physical literacy was, indeed, strongly related to the intention to pursue future physical activity/sport engagement. Lastly, given every individuals' physical literacy journal is unique in that it reflects "…their own capabilities, social and geographical context, and life experiences" (Edwards et al., 2017, p. 118), this exploratory study can be used as a framework for future research conducted in other contexts. This framework can be easily expanded to include additional and/or alternate motivational regulations, psychological well-being factors, physical fitness components, motor skill competences, physical capabilities, and health-related knowledge concepts, which may better reflect physical literacy in the tested context.

Conclusions

As noted, physical literacy is a unique journey that begins at birth and continues throughout the lifespan. However, given many of the affective, physical, and cognitive factors of physical literacy are generally established during youth by PE or sport participation, the window in which to increase these factors of physical literacy may be relatively short for many individuals. Further, knowing physical literacy is purported to determine lifelong physical activity and future sport participation and lifelong physical activity and sport participation are highly related to favorable health outcomes, obtaining an accurate and comprehensive assessment of physical literacy for these formative years seems crucial. In that, knowledge gained from this proposed assessment may help physical educators discover factors of physical literacy that may need enhancement. The present study provides initial validation for a multidimensional measurement model of physical literacy in the context of sixth-grade PE with recommendations on how to further expand on or emphasize relative factors.

Conflicts of interest

The authors certify they have no affiliations or involvement in any organization or entity with any financial interest or non-financial interest in the subject matter or materials discussed in this manuscript.

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