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Adolescents' Daily Lives (ADL) project: an intensive longitudinal design study protocol examining the associations between physical literacy, movement behaviours, emotion regulation and mental health

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ABSTRACT

Introduction Adolescence represents a critical developmental period, with changes in emotional regulation capacities influencing physical and mental health. With less than 6% of Canadian youth currently meeting the 24-hour movement guidelines for physical activity, sleep and sedentary behaviour, there is an urgent need to understand the potential association between movement behaviours, physical literacy, emotional regulation and mental health during adolescence. Additionally, there is a need to better understand these associations among equity-deserving groups. We developed the Adolescents' Daily Lives (ADL) project to identify how, when, under what contexts and to whom to promote healthy engagement in movement behaviours to optimise youth mental health.

Methods and analysis For the ADL project, we will employ a 14-day intensive longitudinal design to investigate the associations between physical literacy, movement behaviours, emotion regulation and mental health among a diverse sample of 120 adolescents (ages 13–17 years) living in the Greater Victoria Area, British Columbia, Canada. A comprehensive baseline survey and movement competence test, assessing physical and mental well-being, 24-hour movement behaviours (ie, physical activity, sleep and sedentary behaviours) and physical literacy, will be accompanied by daily diary surveys and accelerometer-based movement tracking (ie, Fitbit Inspire 3) to assess daily fluctuations in movement behaviour, emotional regulation and mood. Multivariate analyses, including multilevel modelling, multilevel structural equation modelling and Bayesian hierarchical continuous-time SEM, will be used to model the repeated measures data and understand the simultaneous variations in daily movement behaviours, emotion regulation and mental health.

Ethics and dissemination The ADL project received ethical approval from the University of Victoria Behavioural Research Ethics Board (protocol #22-0262). Study participation is voluntary, and data collection will be anonymised to protect participant privacy and confidentiality. Research findings will be shared through academic publications and conference proceedings. Through knowledge mobilisation resources, cocreated with the youth community advisory board, relevant findings will be shared directly with the wider community of adolescents.

STRENGTHS AND LIMITATIONS OF THIS STUDY

⇒ This study uses innovative research design, including intensive longitudinal daily diary design and continuous objective measurements of movement behaviours using accelerometers (ie, Fitbit Inspire 3).
⇒ Within-person variation in daily movement behaviours, emotional regulation and mental health will be analysed using advanced statistical analyses (eg, multilevel structural equation modelling, continuous-time structural equation modelling).
⇒ One-third of the sample will be recruited from the AGM and Black, Indigenous, People of Colour communities, respectively, increasing applicability of our model to underrepresented groups.
⇒ Cross-level moderation analyses may be underpowered; however, are exploratory in nature and will inform future projects.
⇒ Data will not predict future behaviour but will show associations of behaviours at a given time.

INTRODUCTION

Developmentally, adolescence is a critical period for emotion regulation, mental health, physical literacy and movement behaviours (ie, physical activity, sleep and sedentary behaviour including screen time).[1 2] Learning to regulate one's emotions is a critical skill that substantially grows across adolescence,

and poor emotion regulation can lead to a host of negative outcomes such as engagement in risky behaviours, aggression, problems in developing and maintaining friendships and healthy family relationships, school difficulties and mental health concerns making a considerable impact on society.[3] Specifically, emotion regulation is posited to be a transdiagnostic process and an underlying factor in mental health problems across diagnostic categories.[4 5] Indeed, Canadian children and youth are the most likely to experience mental health challenges, with mental illness affecting 1.2 million children and youth, increasing to 7.5 million (one in five) by age 25 years.[6] Rates of adolescent mental health problems have doubled during the COVID-19 pandemic,[7 8] with our own research showing emotion regulation playing a significant role in behaviour problems and mental well-being.[9 10] The COVID-19 pandemic shed light on the ongoing mental health needs of adolescents and continued high rates of mental health disorders postpandemic, emphasising the need for continued work to understand how best to support adolescents.[9–11] Despite this, 75% of Canadian youth with mental health challenges do not receive appropriate mental health treatment.[6] This underscores the urgent need to identify accessible, cost-effective public health interventions, including promoting physical literacy and movement or sedentary behaviours (eg, physical activity, sleep and screen time).

To foster healthy development, the Canadian 24-hour Movement Guidelines for children and youth (ages 5–17) recommend youth achieve 60 min of moderate-to-vigorous physical activity (MVPA), sleep 8–10 hours each night and engage in less than 2 hours of screen time per day.[12] Movement behaviours have been consistently linked to improved youth mental health,[13] yet we see significant declines in these behaviours across the transition from adolescence to young adulthood.[14] Indeed, less than 6% of youth (ages 10–17) meet all three recommendations and 17% of youth do not meet any of the recommendations.[2 12] Moreover, targeted strategies for minimising risks and enhancing adolescent health and well-being are crucial but are not yet well informed by longitudinal evidence, especially among equity-deserving groups (ie, Black, Indigenous, People of Colour (BIPOC), affectional and gender [AGM] youth) suggesting existing strategies and interventions may lack inclusion.[15] Although historically, affectional and gender identity have been discussed together under the umbrella term Two-Spirit, lesbian, gay, bisexual, transgender, queer, intersex, asexual (2SLGBTQIA+), AGM is adopted here as a more inclusive term which accounts for identities not included in the acronym. Informed by a youth community advisory board (YCAB), the Adolescents' Daily Lives (ADL) project will address notable gaps in our understanding of the links between physical literacy, movement behaviours (eg, physical activity), emotion regulation and mental health (eg, anxiety, depression) using intensive longitudinal design and objective accelerometer methodologies.

Our overall goal of the ADL is to identify how, when, under what contexts and to whom to promote healthy engagement in movement behaviours to optimise youth mental health. Our specific objectives of the ADL project are to (see figure 1 for hypothetical model):

1. Objective 1: Increase our understanding of the associations between physical literacy, the recommended

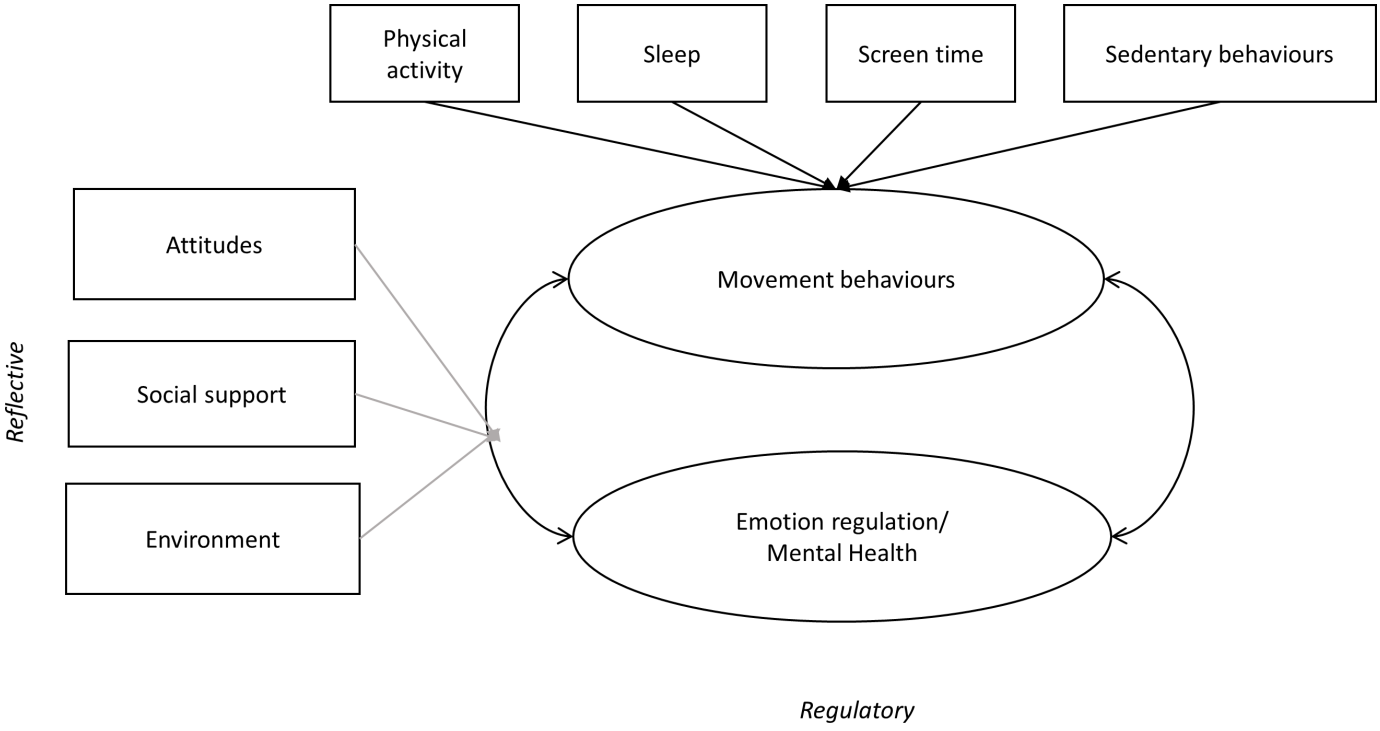

Figure 1 Informed by M-PAC (Rhodes, 2021), hypothesised theoretical model of the continuous iterative feedback loops between movement behaviours, emotion regulation and mental health, as well as potential moderators.

24-hour Canadian movement behaviours (ie, physical activity, sleep and sedentary behaviours), emotion regulation and mental health within the context of ADL. We will model movement behaviours as a single construct to account for their interdependence (figure 1). Subanalyses may further examine the specificity of the movement behaviours and individual predictors within the model.

Hypothesis #1: Adolescents with stronger physical literacy will have movement behaviours that more closely align with the 24-hour movement guidelines, and report more positive mental health.

2. Objective 2: Explore the contexts (ie, individual, social and environmental) that strengthen (moderate) these associations.

   Hypothesis #2: We expect that the associations between movement behaviours and emotional regulation may be stronger for those with health-related motivations or goals when movement behaviours occur with others (eg, parents, peers and in outdoor settings.
3. Objective 3: Test objectives 1 and 2 with BIPOC and AGM youth samples to determine if associations and moderators are consistent compared with a general sample.

   Hypothesis #3: We anticipate similar associations for objective 1 (ie, increased physical literacy results in better movement behaviours and mental health), but potentially a dampened or reduced overall engagement in movement behaviours, as the systems and structures that support physical literacy and movement behaviours are not equitable.

Emotion regulation

Adolescents who can regulate their emotions effectively are better equipped to manage difficult situations and stressors, thereby promoting overall short-term and long-term adjustment and well-being.[16] By contrast, emotion dysregulation is a pattern of maladaptive emotion regulation strategies or the absence of adaptive strategies (eg, difficulty managing emotions or calming down, rumination, suppression, aggression).[3] Developmentally, maladaptive emotion regulation puts youth at risk for negative outcomes such as school problems, poor mental well-being and negative relationships.[3 4] A better understanding of what processes enhance effective emotion regulation is needed, as one in five adolescents report mental health concerns (eg, depression and anxiety).[6] In adolescence, differentiation of emotion regulation increases due to rapid changes in motivation, emotional experiences, and social-contextual awareness (eg, increased sensitivity to others' evaluations) alongside the development of executive functions and self-regulation.[3 17–19] This coincides with significant declines in key movement behaviours (eg, physical activity), in part due to increased demands (eg, academic) and priorities (eg, social belonging),[14] despite adolescence being a critical period for establishing lifestyle behaviour to deter future disease risk and promote well-being.[20] Emerging evidence suggests engagement in physical activity,[21–24] sleep[25–27] and sedentary behaviours (ie, screen time)[28] are associated with emotion regulation. As such, we build on existing research to examine how daily engagement in movement behaviours is associated with emotion regulation and mental health among youth.

Physical literacy

Physical literacy, defined as the motivation, confidence, physical competence, knowledge and understanding to value and take responsibility for engagement in physical activity throughout life, employs a holistic approach where individual factors that influence movement behaviours are examined in concert.[29] There is a lack of studies examining 24-hour movement behaviours using a physical literacy approach within the environmental and social contexts that influence behaviour, which is important as health behaviours exist within the larger context of daily lives.[30] Physical literacy provides a promising approach to understand movement behaviours and there is a need for further evidence to support its utility in the context of daily life, particularly for adolescent movement behaviours. Physical literacy examines physical activity at the individual level, examining physical, cognitive and affective influences on movement behaviour, with clear links to mental health.[29 31] In this study, we examine how physical literacy is associated with daily movement behaviours and mental health.

Movement behaviours

Physical activity

Most of the literature linking movement behaviours to emotion regulation, and mental health comes from the field of exercise psychology, which focuses on physical activity. For example, one study using ecological momentary assessment (EMA) design showed adolescents (N=119; ages 13–17), at the within-person level, were more satisfied with their life on days when they accrued more device-measured physical activity than usual.[32] To our knowledge, no intensive longitudinal design (ILD) adolescent-focused studies investigating the associations between physical activity and emotion regulation specifically exist. While most of the literature has focused on emotion regulation and mood as a consequence of movement behaviours,[33 34] there is increasing recognition of the importance of affect and emotion regulation as a contributor to subsequent engagement in physical activity, and recent theoretical advances tend to include emotion regulation as a key regulatory process that translates behavioural intention into action.[35–40] Ruissen *et al* modelled the continuous bidirectional associations between affect and physical activity in a sample of adults (N=126, ages 18–40) using a 14-day EMA research design.[41] Bayesian continuous-time structural equation modelling (CT-SEM) identified bidirectional and positive feedback loops between both positive and negative affect and physical activity at the within-person level.[42] These findings advance our understanding of the temporal

recursive associations between affect and physical activity; however, future research is needed to replicate and build on these constructs (ie, integration of movement behaviours) focused on the adolescent context.

Sleep

Research suggests that sleeping problems can interfere with emotion regulation, and ineffective emotion regulation may cause sleeping difficulties.[43] This connection is highlighted by studies showing that sleep deprivation leads to altered brain activation in areas related to emotion regulation.[44] Indeed, among a nationally representative sample of 10 148 American adolescents (ages 13–18), Palmer *et al*[26] found past-year sleep problems (ie, difficulty falling asleep, staying asleep or waking up too early) were associated with more self-reported emotion regulation difficulties including suppression, rumination, avoidance and less problem-solving resulting in greater risk of mood and anxiety disorders. Some daily diary research among adults (N=1426; ages 33–84) showed that individuals who are more emotionally reactive to nights of short sleep (≤6 hours) had greater increases in chronic conditions across 8-year follow-up, emphasising the importance of emotional responses to daily sleep and its long-term impact on health outcomes.[27] We will advance this research by examining how sleep is related to emotion regulation and mental health using ILD and an adolescent sample.

Sedentary behaviours (including screen time)

There is a growing body of research linking excessive screen time with negative physical, psychosocial and neurological outcomes.[45] For example, among a large American national random sample of children and adolescents (N=40 377; ages 2–17), Twenge and Campbell[28] found parents of high users of screen time (7+hours/day) were more likely to report poor emotion regulation (ie, not staying calm, arguing too much and being difficult to get along with), among other psychological well-being indicators (eg, inability to finish tasks, difficulty making friends, depression). However, these results are cross-sectional in nature, limiting implications for directionality. There is a lack of research on how emotion regulation may relate to engagement in sedentary behaviours. Adolescents may use screen time to cope with negative emotions, as some research shows emotion suppression to be associated with smartphone use among young adults.[46] Sedentary behaviour or inactivity may also be a byproduct of behavioural inactivation associated with low mood. Nonetheless, the feedback loops connecting emotion regulation and mood to sedentary behaviours require further clarification.

Potential moderators

At the individual level, factors include instrumental attitudes (ie, motivations given an understanding of the benefits of movement behaviours).[33] Individuals also make affective judgments based on how movement behaviours might feel. Social (eg, who an adolescent is with) and environmental (eg, indoor vs outdoor) factors in daily life are also associated with movement behaviours.[45] One's consciously deliberated appraisals about motivations for physical activity are thought to play an integral role in movement behaviour enactment.[35] Indeed, our own work showed young adults (N=496; ages 18–25) who more strongly endorsed physical health as a motivator for exercise had a stronger association between physical activity and depression.[46] Socialisation processes are also important for both movement behaviours and emotion regulation,[3] with research showing parental modelling of physical activity supports and promotes this behaviour.[47 48] Our own research shows physical activity with parents was most consistently associated with lower levels of adolescent mental health problems via emotion regulation pathways during the COVID-19 pandemic.[7] Similarly, adolescents who engage in team sports or with others compared with those in individual sports report greater well-being.[49 50] Physical activity outdoors in natural environments is associated with greater feelings of revitalisation and positive engagement and decreased negative emotions compared with indoor physical activity.[45 51] These studies highlight potential moderating factors influencing the recursive associations between movement behaviours and emotion regulation.

Equity-deserving groups

Engagement in movement behaviours does not happen in a vacuum, and for people from equity-deserving populations, participation in movement behaviours, especially physical activity, comes with additional challenges.[47–49] For people whose identities may reduce or prevent physical activity participation, a focus on community-engaged research is needed to identify the supports and barriers to participation. Several equity-deserving groups, including BIPOC, AGM persons and persons with disabilities, are less likely to participate in physical activity and often report significant barriers to participation.[47–51] AGM youth have significantly higher physical activity dropout rates, partly due to high dropout rates from organised sports with unsupportive or unwelcoming practices.[50 51] There is an insufficient body of evidence on understanding the role of identity and intersecting identities on movement behaviours, emotion regulation and mental health, particularly among adolescents, and a greater emphasis on inclusionary and purposive recruitment practices is needed to understand the supports and barriers to engagement in movement behaviours for youth from equity-deserving groups.[52–55] This is particularly important within the larger social constructs (eg, schools) that youth participate in these behaviours, as the systems and structures that support or prevent these behaviours do not have an equitable impact.

Theoretical approach

Alongside foundational emotion regulation theory,[3 56–58] we call on the modern multiprocess action

control framework (M-PAC) to inform how movement behaviours may be associated with emotion regulation and mental health.[35 59 60] This framework organises some of the most empirically supported factors seen to be associated with movement behaviour change. M-PAC includes three layers of behaviour change: reflective, regulatory and reflexive. The variables of interest of the project make up the reflective and regulatory layers. Attitudes (ie, evaluation of benefits and enjoyment of movement behaviours) are conceptualised as reflective in that they are evaluated consciously when deciding on intentions for movement behaviours. These constructs are operationalised within M-PAC as instrumental attitudes (ie, expected benefits, utility) and affective judgements (ie, expected enjoyment, pleasure), which have been consistently and strongly related to movement behaviours enactment[33 61 62] and include antecedents such as social support and structuring of the physical and social environment.[63 64] Emotion regulation and affect are posited to be important regulatory processes that contribute to the volitional translation of intention into action, thereby reducing the intention-behaviour gap.[35 62] We will test our model (see figure 1) by examining the dynamic changes in pathways over time to inform the temporal sequelae and optimal timing and factors for strengthening pathways within a developmental period vital for establishing promotive neural pathways and long-term behaviour formation.[65–67]

The present study

In sum, evidence supports bidirectional associations between individual movement behaviours and emotion regulation and mental health; however, there is a need to shift focus from individual movement behaviours to holistic movement paradigms, given the interdependence among these behaviours.[46 68] Most studies have limited scope, as they examine unidirectional associations between movement behaviours, emotion regulation and mental health, focusing on one movement behaviour independently or are limited by controlled laboratory, self-report, cross-sectional or group-level data leading to results that may not translate well to daily life nor inform effective interventions. In addition, factors that are integral to our understanding of adolescents' engagement in movement behaviours and emotion regulation and mood are typically time-varying (ie, change over the course of minutes, hours and days) and cannot be adequately assessed using traditional self-reported measures.[69] We also need research that includes equity-deserving groups (ie, BIPOC, AGM) to identify targeted strategies and develop effective promotion of movement behaviours, emotion regulation and mental health for all youth. As such, we will address significant methodological and representational shortcomings of previous research by collecting daily diary data at the start of day and end of day in conjunction with continuous objective psychophysiological measurements. This will permit an ecologically valid examination of the moment-to-moment processes (eg, within-person variations capture the extent to which an adolescent's movement behaviours differ from their own average) involved in the pathways between behaviours, emotion regulation and mental health, as well as identify the factors that strengthen these pathways, with a focus on equity-deserving groups.

METHODS AND ANALYSIS

The ADL project employs an intensive longitudinal design, which allows for comparisons within participants on a day-to-day basis and between participants.[70] All reporting of the ADL project will adhere to Strengthening the Reporting of Observational Studies in Epidemiology guidelines.[71] The ADL project began pilot data collection in February 2024, with a projected data collection end date of April 2026.

Participants

Adolescents (ages 13–17; N=120) will be recruited to participate in the study via advertisements on social media (eg, Instagram, TikTok), posters in teen-focused locations (eg, community centres, youth agencies) and through the researchers' networks. We will purposively recruit AGM and BIPOC youth through advocacy groups if targeted advertisements are unsuccessful. Inclusion criteria are as follows: Participants will be 13–17 (high school aged), living in the Greater Victoria Area, having regular access to a smartphone with data and speak English with sufficient fluency to complete surveys. We will recruit one-third of our sample from the AGM community and one-third from the BIPOC community. Power analysis based on Monte Carlo simulations shows that a sample of 120 youth will be sufficient to detect within-person effects that are small in magnitude and between-person effects that are small to moderate (using the criteria of power=0.80, α=0.05). This sample size is also comparable to studies using similar data analysis. This sample size is also comparable to studies using similar data analysis,[41] and studies with adolescent samples using wrist-worn wearables (Ames *et al*, in prep). Cross-level moderation analyses may be underpowered; however, are exploratory in nature and will inform future projects. Exclusion criteria are as follows: adolescents with injuries or physical limitations.

Procedures

A flow chart of participant procedures is outlined in figure 2. Youth will complete a brief eligibility screening (ie, for age, ability to travel to the university for the initial baseline assessment) and provide their contact information. Undergraduate and graduate research assistants (RAs) then contact eligible participants to schedule baseline assessments and complete informed consent. Participants will meet individually with an RA to complete the baseline appointment (~75 min). At this time, the RA will describe the study and obtain written consent. Following this introduction, the RA will then provide instructions

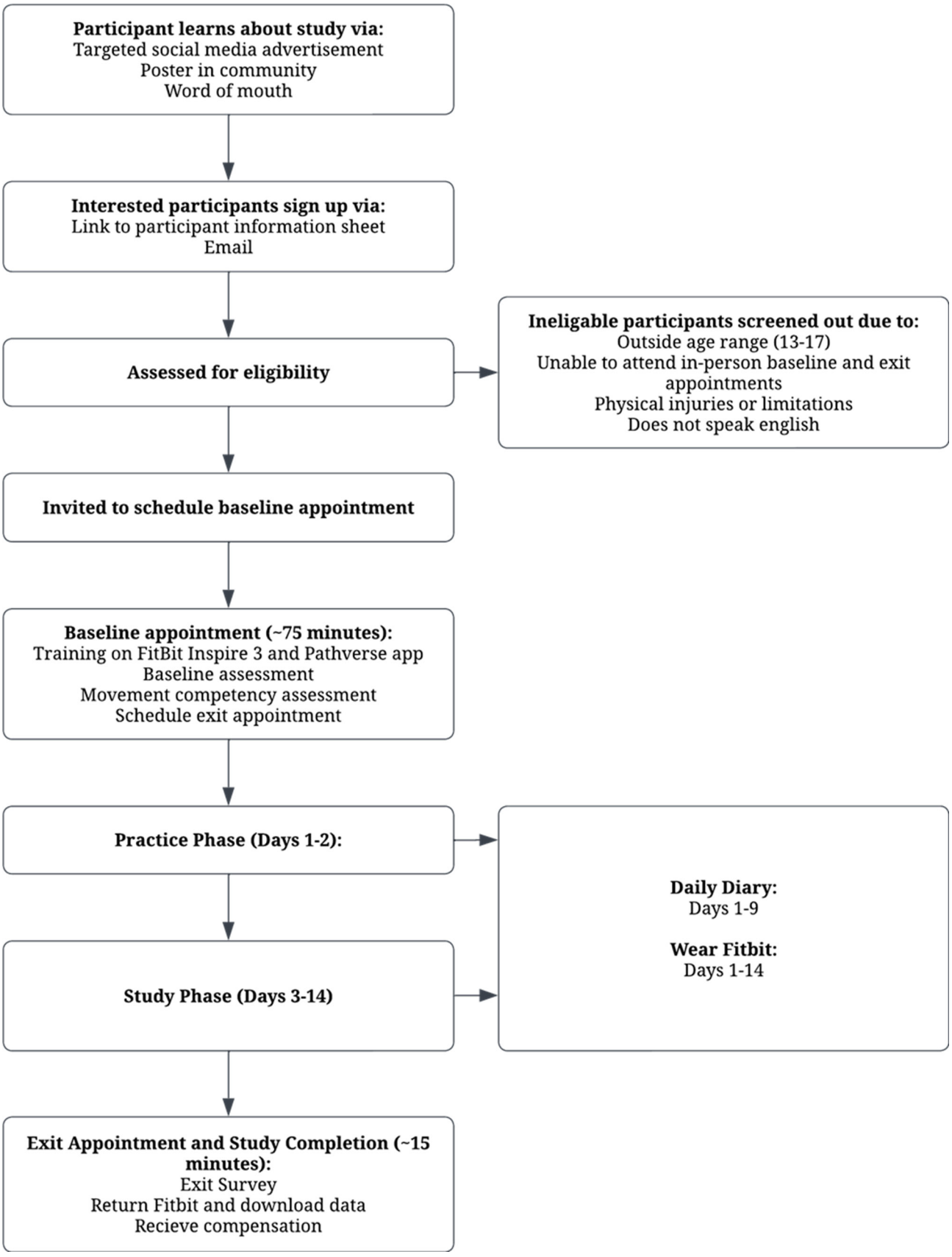

Figure 2 Flow chart of participant protocol.

on setting up the Pathverse mobile application,[72] through which daily surveys will be administered, and the Fitbit mobile application, which will be synced with the Fitbit Inspire 3 to record activity data. Then, participants will complete the baseline questionnaires via REDCap (see online supplemental material). Lastly, participants complete seven different basic movements for the purposes of assessing physical competency.

After completing the baseline appointment, participants will engage in a 14-day study protocol, including a 2-day practice period. RAs will be available for troubleshooting throughout the study period. Following the practice period, participants complete a 7-day daily diary protocol, including a start-of-day and an end-of-day survey (5–10 min assessments), using the Pathverse app. The start-of-day survey includes attitudes, intentions, exercise motivation, sleep duration and quality (including difficulties).[35 73–76] The end-of-day survey includes self-reported physical activity, including items that capture potential moderating factors (ie, motivations, type of activity, social setting, where the activity took place), sedentary behaviours and screen time,[77] stress,[78 79] basic affect and mood (PANAS-C),[80] and engagement in emotion regulation strategies including rumination, distraction, avoidance, suppression, reframing, acceptance and problem-solving.[81] Participants will also wear a wristband accelerometer (ie, Fitbit Inspire 3) for the entire 14-day period which will collect continuous objective information regarding movement behaviours (eg, steps, MVPA and sleep time) and emotional reactivity (ie, heart rate variability). Fitbit Inspire series watches are valid and reliable for measuring activity, sleep and heart rate.[82–84] Incorporating self-report and accelerometer data will allow us to cross-compare the physical activity and sleep data. A total of 10–12 participants can be enrolled in the study at any time, so recruitment and enrolment will continue throughout the data collection period (September–June for 2 years to achieve sufficient N, excluding summer holidays; analyses will control for seasonality).

Measures

Baseline

Baseline measures, examining trait-level emotion reactivity, stress and adversity, attitudes, intentions, motivations, personality, mental health and well-being, and physical literacy, are summarised in online supplemental material. Participants will also provide person-level demographic measures, such as age, sex, affectional identity, gender identity, racial identity and parental education.

We have taken a component approach to physical literacy, with a large emphasis placed on the motivation and confidence components as our previous work has demonstrated that adolescents view these as more influential on their physical activity participation.[85] In order to capture the embodied movement component of physical literacy, participants will video record themselves performing a series of movements, and self-rate how comfortable they felt while moving, and if they felt they were moving smoothly and easily, in order to capture the embodied movement component of physical literacy.[29] These video recordings will also be assessed using existent motor assessments and a supplemental scorer questionnaire.[86–89] Participants will complete a questionnaire, asking about their knowledge around how, where and when they are able to access physical activity to assess the knowledge component of physical literacy. Finally, within the context of Whitehead's conceptual definition of physical literacy, we interpret physical literacy understanding as in line with outcome expectations (ie, understanding of the outcomes of physical activity).

Movement behaviours will be primarily tracked using Fitbit Inspire 3 wearable across the 14-day period. Fitbit devices were chosen because wearable activity trackers have demonstrated high acceptability among adolescent populations.[90–92] Furthermore, Fitbit Inspire 3 is durable and long-lasting, given the devices are waterproof up to 50 m and have 10 days of battery life,[93] which complements the present study's intensive longitudinal design. Sleep data will be collected using Fitbit Inspire 3 wear. In the start-of-day survey, participants will also provide their sleep and wake time from the previous night to verify Fitbit Inspire 3 data. Sedentary behaviour data will be collected using Fitbit Inspire 3, and the type of sedentary behaviour will be verified using end-of-day surveys. Screen time type and duration will be collected using end-of-day surveys. Physical activity time and intensity will be measured using the Fitbit Inspire 3 wearable. Incorporating both self-report and accelerometer data will also allow us to cross-compare the movement behaviour data.

Start of day

The instruments used in the start-of-day daily diary, assessing mood states, anxiety, sleep and intention for physical activity are summarised in online supplemental material.

End-of-day

The instruments used in the end-of-day daily diary, consisting of a comprehensive assessment of mental health, stress, physical or emotional distress, and physical activity behaviours and contexts (ie, social, environmental), are summarised in online supplemental material.

Patient and public involvement: YCAB

We recruited a YCAB in 2022–2023 to support the development of the aims and methodology of this project. 15 local youth (50% from the AGM community) were recruited to discuss physical literacy and physical activity in one in-person interview and at three subsequent focus groups. These discussions led to the importance and intersection of mental health with the constructs of physical activity and physical literacy within their lives. We selected a series of measures based on their shared experiences and provided an opportunity for the YCAB to critique the measures and share questions or constructs

we had not included. This led to the protocol outlined in this paper. Our YCAB also provided insights into where and how to recruit, and what value honorariums participants should receive for their participation. We will meet with the YCAB following data collection to share results and receive their guidance on how best to disseminate the results to a youth audience.

Analysis plan

Bayesian hierarchical CT-SEM will be fit using the ctsem package in R.[41 42] This model can account for the nested structure of the repeated measures data (ie, between-person and within-person levels; measurements nested within participants). The dynamic coupling of within-person processes will be modelled to identify how daily variations in movement behaviours coincide continuously with variations in emotion regulation and affect and mood (objective 1). For example, within-person variability in physical activity refers to how much a participant's daily physical activity differs from their own average. The continuous objective movement behaviours and emotion regulation measures, combined with twice-a-day assessments, provide the opportunity to thoroughly examine the lead-lag effects and the potential bidirectional associations occurring within individuals across their daily lives. Movement behaviors and emotion regulation will be aggregated at the day level, such that time reflects behaviours for that day. Lagged effects of movement behaviours on emotion regulation will examine whether previous day movement behaviours account for current day emotion regulation, whereas lead effects will examine whether current day emotion regulation accounts for subsequent day movement behaviours . An t–1 autoregressive term (AR1) will be included in the model to account for the serial correlation of the outcome variables. The identified moderators (ie, attitudinal, social and environmental) will also be examined to determine whether certain factors strengthen the daily associations between movement behaviours, affect and emotion regulation (objective 2). To inform theory, we will examine BIPOC and AGM identities as separate groups within an SEM multigroup analysis, allowing for differential associations across groups (objective 3). Should there be sufficient youth identifying as both BIPOC and AGM (ie, intersectional identities), this may also be explored as a potential grouping variance. However, we also note that given the paucity of evidence of research on the associations between physical literacy, movement behaviours, emotion regulation and mental health among BIPOC and AGM, we recognise the proposed analyses represent an important first step in this area. Across analyses, missing data will be managed using partial imputation.[94]

Given that the data may be used to inform other research questions, particularly by trainees (eg, 'What are the daily associations between fatigue, pain and mental health?', 'Within individuals, does screen time temporally displace physical activity and sleep?', 'Is there a bidirectional association between screen time and mental health?'), additional statistical analyses may include multilevel modelling and multilevel structural equational modelling.[95–113]

Ethics and dissemination

Ethical approval for this study was provided by the University of Victoria Behavioural Research Ethics Board (Protocol #22-0262). Participants are considered "competent youth" per the University of Victoria ethics guidelines, and parental consent will not be obtained, particularly as AGM youth may not have shared their identity with their parents, and sharing the study purpose may inadvertently "out" participants, risking their safety. However, youth will be encouraged to share their participation with their parents and a letter outlining the study, excluding the intent to recruit AGM youth as a priority population, is provided. Anonymized data will be available at the request of the research team. We will disseminate findings through a minimum of three academic journal articles. We will also share findings at academic research conferences. Together with our youth community advisory board, we will develop knowledge mobilization infographics, social media posts, and videos that we will share in spaces youth frequent (e.g., recreation centres, coffee shops), with schools, and on social media

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Correction notice This article has been corrected since it was published. The states in all the affiliations have been corrected.

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