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Physical Literacy-Based Intervention for Chronic Disease Management: A Quasi-Experimental Study Protocol

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Abstract

Background

As chronic diseases proliferate globally, innovative interventions that promote sustainable physical activity are crucial. Physical literacy - conceptualised as integrating motivation, confidence, physical competence, knowledge, social interaction, and engagement in meaningful activities - offers a holistic strategy for lifelong health promotion. This protocol describes a study investigating the effects of a physical literacy-based intervention on adults with chronic diseases, aiming to enhance long-term physical activity adherence and improve health outcomes.

Methods

This quasi-experimental study will compare three groups: a control group, a group taking part in traditional physical activity (TPA) group sessions tailored for adults with chronic disease focusing on physical fitness general improvement, and a group taking part in TPA sessions that incorporates physical literacy goals and intervention content in line with 6 core dimensions of physical literacy (TPA + PL). Intervention groups will take part in 12 one-and-a-half-hour sessions organised weekly over a 3-month cycle. The study will assess the impact of these interventions using a mixed qualitative and quantitative physical literacy assessment tool at baseline, three months (post-intervention), and six months (follow-up).

Discussion

The study protocol proposes a comprehensive approach to chronic disease management through physical literacy, hypothesising that integrating physical literacy dimensions in tailored physical activity group sessions can significantly improve physical literacy, and consequently physical activity sustainability and health outcomes. Results from this study will provide insights into the efficacy of physical literacy interventions compared to traditional approaches, potentially guiding future public health initiatives and chronic disease management strategies.

Trial registration

NCT06325306 (21/03/2024).

Background

The generalisation of sedentary and inactive behaviours, observable across all age groups, has emerged as a significant health concern from individual to societal levels (1, 2). Despite the well-known health benefits of physical activity (PA), a concerning majority of the global population does not adhere to

international physical activity recommendations (3). Physical activity, when maintained consistently over the long term, is heralded as a primary agent for health prevention, with a pivotal role in effectively averting chronic diseases (4).

However, strategies aiming to promote physical activity have not yet exhausted their full potential effectively, as greater consideration must be given to encourage and measure maintenance of changes, and investigate broader psychological, social and environmental influences of PA behaviour (4). Among individuals diagnosed with chronic diseases, a significant number abstain from exercise regimens (both within and outside of clinical environments), with others discontinuing or failing to maintain regular, self-directed physical activity during subsequent phases (5). As traditional patient care fails to deliver satisfactory results, holistic and patient-centred approaches that take into account the unique characteristics of each participant, particularly in terms of motivation, are essential to achieve lasting behaviour change (6, 7). The decline in daily physical activity is influenced by multifaceted factors ranging from individual determinants to broader societal and institutional frameworks (8–10).

The limitations observed in physical activity promotion are connected to inequalities and disparities in access to health and PA programs and services (11). These discrepancies are often based on environmental factors such as location, with significant differences between city and countryside residents, as well as socio-economic status (12). Additionally, there are constraints related to the limited time, knowledge, and referral to PA specialists among health care professionals (13). This is compounded by a lack of emphasis on the foundations of behaviour change, and a failure to adopt a long-term perspective of participant PA in short-term interventions. Additionally, individuals respond differently to physical activity interventions. While the majority of participants are capable of increasing their adaptation to physical activity during the intervention phase, most find it challenging to maintain and autonomously regulate this adaptation in the follow-up period (14, 15). This variability in response highlights the need for personalised approaches in physical activity interventions, taking into account the unique challenges and capacities of each individual in sustaining long-term behavioural changes. Others have emphasized the need to go “Beyond the Plateau” (16) advocating for strategies to bridge the gap between formal rehabilitation and the integration of exercise into daily life within community settings. This approach suggests a shift towards creating a seamless continuum of care that supports individuals not just in the recovery phase but also in the longer-term adoption of an active lifestyle (17). Some researchers have pointed out a critical gap between healthcare and autonomous physical activity (15, 18). This missing bridge highlights the disconnect between structured rehabilitation programs and the transition to community-based exercise routines that individuals are expected to carry out independently.

This gap hinders the ability of participants to engage in sustainable PA practices within their own communities, creating a barrier to the long-term adoption and integration of physical activity into daily life. Taking into consideration a broader range of determinants of PA participation, such as psychological, social and environmental factors, is therefore largely recommended (18).

In response, the evolving paradigm of 'physical literacy' (PL) has gained momentum. Defined as “the motivation, confidence, physical competence, knowledge, and understanding to value and take responsibility for engagement in physical activities for life" (19), PL encompass physical, psycho-social and cognitive dimensions, reinforcing a lifelong commitment to an active, health-conscious lifestyle (20). Interpretations and operationalisations of this concept differ, but the overarching philosophy envisages physical literacy as a lifelong journey, dynamically evolving based on individual trajectories. Drawing on the concept's health potential marks a non-negligible perspective in PL research (also supported by (21, 22). Cognizant of the different conceptualisations of PL (23), we emphasize the health-promoting perspective of the concept in respect with the human embodied dimension, associated with the intrinsic value of physical activity.

Historically, the discourse around PL has been predominantly anchored in Anglo-Saxon nations (24, 25). Within Europe, efforts have been made to promulgate the concept, as evidenced by a collaborative publication underscoring the necessity for age-specific PL measurement tools (24). Despite the heterogeneous situation across Europe, a recent state of implementation in research, practice and policy analysis has uncovered similarities among the countries, such as the presence of established yet not identical concepts (25). Unfortunately, existing validated metrics have been disproportionately skewed towards school-aged populations, predominantly young children (26). Preliminary findings among younger demographics have been promising, indicating that higher PL scores correlate with greater adherence to physical activity and sedentary behaviour guidelines (27). At present, only a few studies extend research on PL to adults and almost none cover older adults or those with chronic diseases (28, 29). Furthermore, there is a greater emphasis on the physical domain of PL, with an underrepresentation of the affective, cognitive, and behavioural domains in the actual studies (22). First physical literacy interventions exposed significant effects on all main outcomes of physical literacy, with the strongest effects were found for the physical domain, followed by (in descending order) cognitive, behavioural, and affective domains (30). This imbalance in research and outcomes points to a need for more holistic investigations into all facets of physical literacy (31).

While young populations have been the primary beneficiaries of physical literacy-centric interventions, adults also require tailored tools and interventions (32, 33). Such instruments can empower health and physical activity professionals to design and execute more effective interventions. To date, existing scientific literature concerning physical literacy in a health context remains scant (22). Physical literacy in health care setting is then identified as one of the “blank spots” for exploration in the field (34). There is a significant lack of evidence in specific clinical populations such as chronic disease patients. Additionally, the concept of physical literacy has not yet been fully embraced in practical applications by healthcare practitioners, indicating an opportunity for growth in incorporating this construct into healthcare education and clinical practice.

As the interest over PL in the field of public health grows, Cairney et al. (21) highlighted the need for the generation of new research questions and the possibility of broadening impact beyond the context of physical education alone, positioning physical literacy as a determinant of health means. Therefore, the

goal of the present study is to bridge this knowledge gap by offering an exploration of the development and evaluation of a physical literacy intervention, precisely tailored for chronic disease patients attending traditional physical activity (TPA) group sessions in Belgium. The present initiative has been supported by a previous pilot study with a quantitative, within-subject design that has evaluated physical literacy among patients with chronic diseases in medical centres (35). Participants, referred by healthcare professionals, underwent two PL assessments and counseling sessions, culminating in setting SMART goals based on motivational interviewing techniques. Results revealed significant improvements in overall PL and the cognitive and physical domains, but not in the psychological and social domains. Encouraged by these findings highlighting the potential benefits of continuous PL support for adults with chronic diseases, we now aim to test the interventional approach through a more rigorous, advanced design.

Methods

1. Study Design

A quasi-experimental approach was adopted for this investigation, focusing on chronic disease patients enrolled in tailored physical activity group sessions. We followed the guidance for protocols of clinical trials to elaborate our study (SPIRIT 2013 checklist; (36)). The Physical Literacy Interventions Reporting Template (PLIRT) was used to organise the planification and reporting of this intervention (37). The 16-items PLIRT for mixed-methods studies was designed by experts in the field to facilitate improved transparency in and interpretability of reports on PL interventions. Our Checklist (see additional file 1) provides a systematic statement of the consideration of each item of the PLIRT.

This study utilises a quasi-experimental design with three distinct arms: one control condition (no intervention) and two experimental conditions, each aimed at examining different types of intervention for chronic disease management. The structure and purpose of each arm are outlined as follows.

2. Participant and recruitment

For the current study, participants will be recruited from the 'Citoyen, en mouvement pour ma santé' (translation: “citizen, moving for my health”) program, a joint initiative by the University Hospital of Liège and the University of Liège. This program targets adult individuals with chronic diseases, offering physical activity sessions in community settings within the Wallonia-Brussels Federation.

Participants will be allocated to each group non-randomly, ensuring clear differentiation in intervention strategies. The comparative analysis across these groups is intended to provide an understanding of the potential impact of physical literacy in TPA programs for chronic disease patients. The study is designed to objectively assess the effectiveness and practicality of each approach in real-world settings.

Eligibility criteria for participation in the study include being at least 18 years old, having a least a chronic disease diagnosis, possessing a medical clearance to participate in physical activities and being enrolled

in the 'Citoyen, en mouvement pour ma santé' program. Informed consent will be obtained from all participants prior to the start of the study.

This recruitment approach is pragmatic, considering the availability of participants and the logistical aspects of organising group-based interventions in community settings (38, 39). It also allows for an examination of the interventions within a real-life context, which is critical for understanding the applicability of the findings in public health practice.

a. Control Group (CONTROL)

Participants in this group will not receive any specific intervention. It will be composed of individuals from “waiting-list” local communities who are registered to join the program after the study period. This approach, creating a waiting list control group, is intended to provide a comparison baseline against the intervention groups. It also ensures that all participants, including those in the control group, will eventually have access to the physical activity program, aligning with ethical best-practice standards for research. This arm serves as a baseline, allowing for observation of the natural progression of health indicators in the absence of targeted interventions. Data from this group will be crucial for establishing a reference point against which the outcomes of the intervention groups can be compared.

b. Traditional Physical Activity (TPA) program group

The recruitment for the traditional physical activity (TPA) group will consist of individuals from local communities that are already actively running the program. This arm involves participants engaging in a traditional PA program, tailored to the needs of individuals with chronic diseases. The focus here is on physical fitness and mobility, without the explicit integration of PL elements. The aim is to assess the baseline effectiveness of conventional physical activity interventions in this specific population. In order to ensure optimum comparison between the intervention conditions, the same and unique physical educator will supervise all sessions and will follow the same general physical condition improvement goals and intervention content between the two conditions. Only the incorporation of explicit PL oriented content (see Table 1) will differ between those two conditions.

Table 1
Detailed overview of the PL-oriented tailored physical activity program (TPA + PL) content

Session n°	Goal	PL-oriented content focus
1	Pre-intervention PL assessment	30 minutes of LP evaluation; group divided into two: 15 minutes of questionnaires for group 1 and 15 minutes of physical tests for group 2 and vice versa.
2–7	(1)+(2)	1. Raise awareness of current personal physical activity (PA) habits in playful form. 2. Encouragement to practice through the provision of monitoring tools (watches, pedometers, home exercises, calendars) inviting participants to initiate the practice of PA outside the session.
3–8	(1)+(3)	1. Information and awareness about PA in and its dimensions (types, recommendations, benefits). 2. Exchange on the physical environmental offer (park, trails, sport facilities, etc.) and social (sports group, association, etc.) of AP available at local level.
4–9	(1)+(4)	1. Experimentation of collective/cooperative exercising situations (pairs or groups). 2. Invitation to extend practice outside the sessions by involving the entourage; awareness of the participant's potential role as an PA initiator. 3. Invitation to practice between participants beyond the session cycle.
5–10	(1)+(5)	1. Collective identification of key barriers to participant PA; valuing the progress of each. 2. Role-playing, taking responsibility of the participants in the session to increase the perception of skills.
6–11	(1)+(6)	1. Sensitisation of the participant towards PA who have meaning in his daily life. 2. Diversification of exercise modalities (music, groups, new formats) to solicit pleasure. 3. Autonomous choice of exercises and modalities by participants
12	Post-intervention PL assessment	30 minutes of evaluation LP: Group divided into two: 15 minutes of questionnaires for group 1 and 15 minutes of physical tests for group 2, and vice versa.

Legend: (1) Physical competence (2) Physical activity behaviour/engagement in physical activity (3) Knowledge/understanding (5) Motivation and confidence for physical activity (6) Environment interactions (6) Meaningful/purposeful activities

c. Physical Literacy Oriented traditional physical activity (TPA + PL) program group

As for the TPA group, Physical Literacy Oriented traditional physical activity group (TPA + PL) will consist of individuals from local communities that are already actively run the program. In this group, participants will take part in a traditional physical activity program that incorporates physical literacy elements (see Table 1). This approach goes beyond physical fitness enhancement, aiming to improve participants' engagement with physical activities through increased motivation, confidence, knowledge, and understanding. This arm will explore whether the addition of physical literacy components can offer any additional benefits or present unforeseen challenges compared to the TPA approach.

3. Sample Size Determination

The study includes a control group, a traditional Physical Activity (TPA) group, and a TPA Physical Literacy-oriented TPA (TPA + PL) group. Utilising G*Power software for power analysis, we aim to detect an effect size of 0.40, with a targeted statistical power of 80% and a significance level (α) of 0.05. Based on these parameters, the analysis indicates a need for 52 participants per group. In order to account for potential dropouts (20%), we plan to recruit 65 participants per group for this trial to maintain the study's validity. An intention-to-treat (ITT) approach will be used to analyse participants based on their assigned groups regardless of protocol adherence. This method ensures unbiased treatment effect estimates and reflects real-world application. For missing values, we will utilise multiple imputation techniques to maintain the integrity and robustness of our results, minimising bias from data loss.

4. Materials and Instruments

In our aim to identify suitable assessment tools for PL among adults, particularly chronic disease patients, a comprehensive literature search was conducted. It became evident that there are limited validated tools specifically for this demographic in the current literature. Most existing instruments are self-reported and primarily focus on the physical domain of physical literacy. These tools are not designed to provide follow-up data on physical literacy that is readily usable by health professionals in the sector (40). A review by Cornish (22) revealed that 94% of the considered articles utilised the Whiteheadian definition of physical literacy. This definition is consistent with that of the International Physical Literacy Association (19) and the two are often cited interchangeably due to their similarities. Furthermore, Petrusevski (29) spotlighted the most frequent components of PL in studies concerning aging adults, including engagement in physical activity, meaningful/purposeful activities, motivation, confidence, knowledge and understanding, and social interaction.

The preliminary tool used in our previous physical literacy intervention delivered in a medical centre setting (35) was also used as a reference. This tool includes a 40-item questionnaire and 4 physical tests, divided into 4 domains of PL (psychological, social, cognitive, physical), and allows the calculation of a global PL score. However, considering the broader scope of components to be framed in PL among adults highlighted by the recent literature, we decided to extend our initial assessment.

For this study, our assessment tool will integrate six core dimensions of physical literacy:

- Physical activity behaviour and engagement

- Physical competence
- Motivation and confidence
- Knowledge and understanding
- Social interaction
- Meaningful and purposeful activities

Our tool (see additional file 2) incorporates closed-ended questions for each of the six dimensions, offering a concise score to track participants' progress. As far as possible, items were extracted from existing validated tools. Open-ended questions are also included to stimulate discourse on physical literacy, providing a platform for more personalised advice from the physical activity educator. Carl et al.'s recent work (34) highlighted the significance of qualitative assessment components as a prevailing gap in physical literacy research. By integrating these elements, professionals are better equipped to offer guidance and interventions aligned with broader physical health and well-being goals.

a. Physical activity behaviour and engagement

Physical activity behaviour and engagement represent a critical dimension of PL that refers to the frequency, intensity, and regularity with which individuals participate in physical activities. It involves making conscious choices to integrate physical activity into daily routines, reflecting an individual's dedication to health and well-being. This dimension is underpinned by the concept that sustained engagement in physical activities is a key indicator of an individual's PL. In our study, this dimension is assessed using questions from the International Physical Activity Questionnaire - Short Form (IPAQ-S; (41)). It is a validated tool designed to assess physical activity levels in adults. It captures data across various intensities, including walking, moderate, and vigorous activities, over the preceding 7 days. The questionnaire comprises seven items, encompassing domains such as work-related, transportation, domestic, and leisure-time activities. For the purpose of this study, we decided to only integrate in our questionnaire the six items allowing the calculation of total weekly physical activity by computing metabolic equivalent (MET) minutes per week. An extra item was added to provide with the number of days performing muscle-strengthening activities, making it possible to compare the results obtained with the WHO international recommendations for physical activity in adults (3). The open-ended question related to this dimension asked participants what (quality) physical activities they currently practice during their leisure time, transportation, at work, or at home (see additional file 2).

b. Physical competences

The concept of physical literacy encompasses more than just the knowledge or motivation to move; it dives into the tangible abilities individuals possess, making the assessment of physical competence crucial for adults (32). Through physical assessments, professionals can discern specific strengths and weaknesses, and ensure for a tailored and safely engagement in PA, especially for participants with chronic conditions (4). Physical competence is intricately linked with an adult's ability to perform everyday tasks, particularly as they age: ensuring robust physical competence can directly contribute to

improved functional capacity, promoting independence and enhancing quality of life (42). We includes aerobic endurance, strength, flexibility, and balance brief assessments within this physical literacy tool for adults (see additional file 2). These domains have been substantiated by various scientific studies and hold significance in understanding one's physical competence (43, 44) The recommendation to assess these domains aligns perfectly with international recommendations for physical activity in adults, older adults, and chronic disease patients (3). Emphasizing these domains complements the holistic intent of a physical literacy tool, ensuring individuals are not just moving but moving effectively, safely, and in a manner that promotes long-term health.

Endurance

By assessing endurance, professionals can gauge an individual's capacity for sustained physical activity and their potential risk for these conditions. Moreover, endurance has implications for functional fitness; the ability to perform daily activities without undue fatigue is rooted in one's aerobic capacity (43). We used the 2-minute walking test (2MWT), a submaximal exercise test used to evaluate functional exercise capacity in adults, especially in those with chronic conditions. It entails recording the distance a person can walk on a level surface within 2 minutes. The 2MWT serves as a more concise alternative to the frequently employed 6-minute walking test (6MWT). Excellent correlations with the 6MWT have been observed in older adults or long-time care population ($r = 0.93$; (44)). It offers similar predictive and discriminative properties in specific populations (45). One of its main advantages is its shorter duration, which makes it particularly suitable for patients with significant limitations or who tend to tire quickly. The 2MWT has been shown to be responsive to interventions, enabling clinicians to gauge the efficacy of treatment and rehabilitation programs (46).

Strength

Strength training or resistance-based activities have been recognised for their benefits in preserving lean muscle mass and prevent sarcopenia, functional impairments and increased risk of falls; this is especially crucial as one ages or is affected by a chronic disease (47, 48). Assessing strength can provide insights into an individual's resistance to such degenerative conditions. In this tool, we use a test from the Senior Fitness Test (SFT), a battery of tests specifically designed to assess the functional fitness of older adults (43): the 30-second Chair Stand Test (Sit to Stand Test). It assesses the lower body strength. Lower body strength is essential for tasks such as climbing stairs, walking, and getting out of a chair or bed. This test is indicative of leg strength and endurance. The participant starts by sitting in the middle of a chair, arms crossed at the wrists and held against the chest. On the command "go", the participant rises to a full stand and then sits back down, repeating as many times as possible for 30 seconds.

Flexibility

Flexibility, while often overshadowed by endurance and strength (49), holds its unique importance. Improved flexibility contributes to a broader range of motion (e.g., daily life physical tasks), reduced muscle stiffness, and a decreased risk of musculoskeletal injuries (50). In this tool, we use the Sit and

Reach test, a widely recognised measure assessing flexibility, specifically of the hamstrings and lower back. Participants sit with straight legs and lean forward, trying to reach as far as they can. This test's significance is highlighted in its ability to predict potential lower back pain, as restricted flexibility in these areas has been linked to lumbar issues (51). Moreover, adequate flexibility is pivotal for daily activities, with its relevance magnified in older adults and those with chronic conditions for whom functional mobility is crucial. For chronic diseases like Parkinson's, consistent flexibility assessment can help improve disease management and quality of life (52).

Balance

The incorporation of a balance assessment within a PL tool for adults is of paramount importance, given its direct implications for functional independence and fall prevention. As adults age, balance proficiency becomes crucial in averting falls, which are a leading cause of morbidity and mortality among older adults (53). Furthermore, enhanced balance abilities have been linked to better performance in daily activities, overall mobility and quality of life (54). In this tool, we use the one-leg balance test to gauge static balance in individuals (55). To execute this test, participants are required to stand on one leg without support, with the duration of balance maintained serving as the primary measure. For chronic disease patients with these conditions, regular balance assessments can offer crucial data about disease progression and the efficacy of therapeutic interventions (56). The one-leg balance test's appeal lies not just in its relevance but also its simplicity. Requiring no elaborate equipment, it can be administered virtually anywhere, making it particularly suitable for diverse settings and populations.

c. Motivation and Confidence

Motivation and confidence to participate in physical activities are identified as key factors to attaining physical literacy for individuals of all ages (57). Within the PL model, motivation refers to a person's enthusiasm and pleasure in embracing physical activity as an integral part of life (19). It is an important predictor of initiation and maintenance of long-term PA adherence across lifespan (58). (35)Two closed-ended questions (Likert scale) related to motivation and confidence for the integration of regular physical activity in daily life are included, based on the preliminary tool ((35) – see additional file 2). Participants will also be asked to freely report (open-ended questions) their perceived facilitators and barriers to integrating physical activity into their daily lives. Those answers could help the physical activity professional to identify and counsel, individually or collectively, about ways to amplify facilitators or to overcome perceived barriers.

d. Knowledge and Understanding

Understanding the knowledge and understanding dimension of PL is crucial as it helps individuals make informed decisions about their physical activities, thereby promoting lifelong engagement and well-being. Knowledge and understanding can positively influence attributes of motivation, confidence, physical competence, and fluent interactions grow (20). It refers to a person’s knowledge about how to perform a variety of physical activities as well as a person’s knowledge of the everyday relevance of exercises and the health benefits of physical activity in general (59). Relying on the core categories

defined by Edwards et al. (57) within the cognitive domain of PL, we decided to integrate three items assessing this domain (see additional file 2). Two closed-ended questions ask the participant about their (1) perceived value of taking part in regular physical activity and (2) their perceived knowledge/understanding of main exercising guidelines (e.g., warm-up, progressiveness, and recovery) for health-related purposes. Finally, an open-ended question asked participants to write down what they know about WHO recommendations (3) for aerobic PA.

e. Environment interaction

Perceived environmental opportunities, both social and physical, could be informed by physical activity professionals and play a crucial role in influencing physical activity among adults, particularly those with chronic diseases. Being aware of supportive surroundings opportunities, like accessible walking paths, parks, or sport facilities can promote routine exercises (60). Besides, social interaction, in the context of physical literacy, underscores the importance of interpersonal relationships, communication, and community involvement in promoting and maintaining physical activity. For adults, especially those with chronic diseases, social interactions can have a profound influence on their engagement in physical activity and overall health outcomes (61). In this tool, two closed-ended questions (likert scale – see additional file 2) are asked over the perceived support from peers (family, friends, etc.) for physical activity and over the perceived environmental (social and physical) opportunities for physical activity. Additionally, an open-ended question asks participants about the people and places that they would consider as helpful to help them to take part into a regular physical activity practice.

f. Meaningful and purposeful activities

Meaningful and purposeful activities are foundational elements in a physical literacy assessment tool, especially for adults and individuals with chronic diseases. Whitehead (20) posits that meaningful engagement in physical activity is more than mere participation—it's about understanding and valuing the relevance of the activity to one's life. For adults, especially those with chronic conditions, this dimension of meaning becomes even more significant. Engaging in activities that resonate with an individual's values and interests leads to enhanced commitment, sustainability, and psychological well-being (57). Moreover, when physical activity is intrinsically rewarding and associated with positively balanced affective responses, it supports not only the physical but also the emotional and social aspects of health (62). This aligns with the comprehensive nature of physical literacy, where meaningful engagement is central to promoting lifelong physical activity. Therefore, integrating meaningful activities into physical literacy assessments ensures a holistic approach, which is more likely to result in sustained, purpose-driven physical engagement.

In this tool, two closed-ended questions (see additional file 2) ask participants about their perceived pleasure in taking part in physical activity, and about their perceptions of the meaningfulness/purposefulness of integrating physical activity in their daily life. Finally, participants are asked to describe in an open-ended question the characteristics of physical activities that they would personally consider as meaningful/purposeful.

5. Assessment procedure

The tool is designed to be administered autonomously by the professional educator during the tailored physical activity sessions. However, for the purpose of this research, the educator is supported by a second person (researcher) for the days of assessment. Blinding of the deliverers cannot be realised as they were specifically employed for the purpose of this study. The professionals have acquired a master degree in physical education and/or physiotherapy with an additional training in exercise therapy.

Assessment of participants are undertaken every 3 months, for a total duration of 6 months. This procedure coincides with the beginning (T0) and the ending (T + 3 months) of a semester of tailored physical activity sessions, end after a follow-up period of 3 additional months (T + 6 months). During the follow-up period, participants will be asked about their continuation of any structured PA or other encouragement for PA continuation by health or exercise professionals to control for other significant influential factors.

During the assessment, participants are divided into two subgroups: (1) a group performing the physical tests supervised by the physical educator, and (2) a group performing the written assessment of the other 5 dimensions of the tool supervised by a researcher. Each sub-assessment is expected to last about 15 to 20 minutes, before groups are changing tasks. The assessment are performed at the beginning of the session, after a standardised warm-up (15 minutes; light aerobic activity and mobilisation), to avoid bias related to an acute fatigue due to the exercising activities.

Assessments use a mixed qualitative and quantitative data processing method. Answers from the participants closed-ended questions (likert scale), physical tests and physical activity behaviour are supplemented with a qualitative assessment raising from an open-ended question for each sub-dimension. A triangulation process between those categories of data will be undertaken to better to gain a more complete picture of the intervention effects (63). Adherence to the intervention was assessed by calculating the ratio between attended intervention days and theoretically possible intervention days, expressed as a percentage.

6. Intervention content

During the intervention, 12 one-and-a-half-hour sessions are organised weekly over a 3-month cycle. The first session is primarily focused on the PL assessment, followed by a comprehensive introduction to physical conditioning exercises. In each of the subsequent sessions (n = 10), participants of the TPA and TPA + PL groups will receive an intervention focused on the development of their physical fitness (endurance, strength, flexibility, balance). The physical instructor will use a standardised program in those two groups. Principles of pedagogical intervention will be identical in both groups and will led by the educators. Each session will commence with a fifteen-minute warm-up comprising of a blend of cardiovascular and joint mobilisation exercises. The warm-up routines will vary from one session to another to expose participants to a range of activation techniques, allowing them to explore the joy of diversifying their practices. The core part of each session, lasting one hour, will be dedicated to session-

specific exercises targeting key physical competencies such as endurance, strength, flexibility, and balance, along with other motor skills. A variety of training accessories including elastics, medicine balls, Swiss balls, and mats, as well as diverse conditions like music, room arrangements, and both individual- and group-centred exercises, will be employed by the PA professional. The size of the group will never exceed a number of 15 participants. At the conclusion of each session, participants will be guided through a return-to-calm sequence that included stretching and relaxation exercises. This time also provide an ideal opportunity for participants to express their feelings about the activities and their overall relationship with physical activity. During those recovery periods and exercises, the instructor will not only provide guidance on correct exercise execution but will also highlight the "everyday relevance" of each exercise and the opportunities for applying them in daily life. In the context of physical education, Cloes (64) defines it as the societal transfer, “anything the physical education course brings to students that they will be able to use in their daily lives, throughout their lives”. The health benefits of exercise and regular physical activity will also be discussed (65). The final session is reserved for the end-of-cycle assessment and concludes with a socially-oriented activity, notably a "social tea."

In the TPA + PL group, all sessions will be designed in accordance with the principles outlined in the Physical Literacy Interventions Reporting Template (PLIRT; (37)). A particular and explicit emphasis on PL dimensions will be added during the sessions. While the dimension of physical competence is consistently incorporated into the sessions, the remaining five dimensions are addressed twice over the course of the semester with the setting of specific goals and intervention content.

Insert Table 1 here -

Other PL domains are only explicitly addressed by the educator as a reminder of previous objectives and content. This could involve quizzes or games integrated into circuits or exercise workshops, role-play exercises simulating real-life situations, or social interactions between participants with a particular focus on PL-related topics. In addition to the sessions, a follow-up telephone call is scheduled between the educator and each participant in the TPA + PL group during the two weeks following the initial PL assessment. These conversations aimed to share individual PL assessment results and assist participants in setting person-centred goals using a motivational interviewing technique (66). Goals could relate to any of the PL dimensions, depending on the motivation of each participant.

7. Data analysis

In this study, the primary outcomes will focus on the quantitative assessment of changes in the global score of Physical Literacy and its six dimensions: Physical Activity Behaviour/Engagement, Motivation and Confidence, Knowledge/Understanding, Physical Competence, Environment Interaction, and Meaningful and Purposeful Engagement. Each dimension will be provided with an aggregated score out of 8 points, with a maximum score of 48 points. Score for PA behaviour/engagement relies on the IPAQ-S scoring protocol (low, moderate or high level of PA; /6 pts) and on the achievement of WHO recommendations for regular strength training activities (/2pts). The score for physical competence will be based on the scoring scales used in our preliminary study (35), with 2pts attributed to each physical

test. Scores for the other dimensions will be calculated according to the level of answer given on each 4-point likert scale (4pts per scale). Measurements will be taken at baseline and post-intervention to evaluate any changes or developments in PL.

Secondary outcomes will include qualitative insights gathered from open-ended questions. From the raw responses, a process of preliminary data coding using a combination of deductive codes drawn from the research questions and inductive codes generated by the data will be undertaken. As the coding progresses, recurrent codes will be grouped in overarching categories (67). In a triangulation process (63), it will complement the quantitative data, offering a richer, more nuanced understanding of how the interventions impact participants perceptions of dimensions of PL.

Additional analyses will include subgroup analyses based on age, gender, and type of chronic disease. Adjusted analyses will be performed to control for potential confounders through multivariate regression at baseline. Both primary and secondary outcomes will be assessed at specified time points, including at 3 months and 6 months post-intervention. This dual approach, integrating quantitative and qualitative methods, is designed to provide a comprehensive evaluation of the PL interventions, capturing not only the statistical changes in PL scores but also the personal and subjective experiences of the participants in their journey towards improved physical literacy.

Results will be presented as mean and standard deviation (M ± SD) for continuous variables or as frequency (%) for categorical variables, unless otherwise specified. The normality of distribution for each continuous variable will be assessed, with skewness values below − 1.96 indicating normality (68). Baseline comparisons between the three groups – control, traditional Physical Activity (TPA), and TPA with Physical Literacy (TPA + PL) – will be conducted using one-way ANOVA for normally distributed data, or Kruskal-Wallis tests for non-normally distributed data. Chi-squared tests will be used for categorical variables. To evaluate the reliability of the PL questionnaire, Cronbach's alpha coefficient (α) will be calculated as an indicator of internal consistency. An α value of ≥ 0.7 will be considered indicative of acceptable internal consistency.

The primary analysis will involve mixed ANOVA models to analyse both changes within subjects over time and differences between groups on the physical literacy aggregated score and domain scores. Individual variability will be modeled as a random factor. In cases where the mixed ANOVA indicates a significant difference, Bonferroni-adjusted post hoc analyses will be conducted to assess specific within- and between-group changes over time.

Effect sizes for the ANOVA results will be calculated using partial eta-squared (η_p^2), with $\eta_p^2 \geq 0.01$ considered small, $\eta_p^2 \geq 0.06$ moderate, and $\eta_p^2 \geq 0.14$ large. Additionally, for pairwise comparisons, Cohen's d will be used, with $d \geq 0.2$ denoting a small effect, $d \geq 0.5$ as moderate, and $d \geq 0.8$ as large (68). The Expectation-Maximization (EM) algorithm will be employed to impute missing data arising from dropouts or incomplete records, ensuring comprehensive and unbiased analysis in our intention-to-treat

approach. All statistical analyses will be conducted using the software R. Statistical significance will be set at a two-tailed *p*-value < 0.05.

Discussion

This study aims to explore the integration of PL intervention in physical activity group sessions tailored for chronic disease management. We anticipate that our findings will contribute significantly to the current understanding of PL's role in this context. Specifically, we expect to observe improvements in some domains of physical literacy. Factors such as the intervention's duration, the assessment tools used, or the specific nature of the chronic diseases involved could influence these outcomes. As the programme 'Citoyen, en mouvement pour ma santé' is open to all types of chronic disease, and in an exploratory setting, we chose to prioritise a broad inclusion of participants rather than a specific targeting.

If physical literacy is found to have a positive impact on chronic disease management, this could make consider a wider inclusion of this concept in the management of chronic disease patients. Our findings will help to discuss potential strategies for integrating PL into health promotion and management settings.

Moreover, we acknowledge that our study will have limitations, such as that it applied a non-randomized design and potential sample size constraints. These limitations will be important to consider when interpreting our results. We will suggest future research directions, including the need for long-term studies, a more focused impact assessment in different types of chronic diseases, or employing further validated PL assessment tools. Such research could offer deeper insights into the role of PL across diverse patient populations.

In conclusion, our study seeks to shed light on the potential benefits and challenges of incorporating physical literacy into chronic disease management. We will aim to provide a comprehensive analysis that not only highlights the successes but also critically examines the areas where further development is needed. By doing so, we hope to pave the way for future research and practical applications in this emerging field of study.

Abbreviations

AP
Physical Activity
PL
Physical Literacy
TPA
Traditional Physical Activity
TPA + PL
Traditional Physical Activity with Physical Literacy

PPLQ
Perceived Physical Literacy Questionnaire
IPLA
International Physical Literacy Association
M ± SD
Mean ± Standard Deviation
ANOVA
Analysis of Variance
PLIRT
Physical Literacy Interventions Reporting Template
CHU
University Hospital of Liège
CI
Confidence Interval
ηp2
Partial Eta Squared

Declarations

Ethics Approval and Consent to Participate

This study involving human participants was reviewed and approved University Hospital of Liège Ethics Committee (reference number 2023/392 dated 02/02/2024). Informed consent to participate in the study will be obtained from all participants prior the enrolment in the study.

Consent for Publication

Not applicable. This protocol does not contain any individual person's data in any form.

Availability of Data and Materials

The datasets generated and/or analysed during the current study will be made publicly available on searchRxiv (https://www.cabidigitallibrary.org/journal/searchrxiv).

Competing Interests

The authors declare that they have no competing interests.

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Authors' Contributions

All three authors contributed significantly to this work. AM and JPW were involved in the conception, design, data collection, intervention development, analysis, and manuscript writing of this protocol. AM wrote the first draft of the protocol, then JC and JPW contributed to the review and editing of the manuscript. AM, JC, and JPW, have read and approved the final manuscript.

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- Additionalfile2PhysicalLiteracyAssessementTool.docx