



PHYSICAL ACTIVITY OF THE ONCE YOUNG AND THE YOUNG ONES: A SUSTAINABILITY MODEL

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ABSTRACT

Physical activity (PA) was a key element for the attainment and maintenance of a healthy life throughout all ages, and its life course persistence was a significant public health problem, particularly in the rapidly aging context of China. We aimed to identify factors determining the life course persistence of PA, develop an intergenerational model of PA persistence and teaching intervention through research on two intertwined groups—young adult university students (18 y o) of Nanchang University, and middle-aged adults (40–50 y o) living in nearby communities. We used an innovative "retrospective synthesis plus teaching intervention" mixed methods design and integrated the theoretical frameworks of social cognitive theory (SCT), life course development theory (LCDT), and habit formation theory (HFT). 100 young adults and 100 middle-aged adults were included in the study. Quantitative data were obtained by questionnaires, and qualitative data were obtained by semi-structured interviews with the middle-aged adults. Results showed a medium positive correlation ($r=.487$, $p<.001$) between adolescent PA habits and midlife PA levels, defined life stage transitions (e.g., student to working professional; life with child) as the critical vulnerability windows where PA discontinuity was more likely, and concluded that social support was more strongly associated with PA persistence than physical environment infrastructure. Building upon these findings, we proposed a four-component life course PA persistence model including adaptive habit structure, intergenerational teaching and learning of physical activity, socio-environmental support structure, and evidence-based intervention approaches. Teaching intervention targeting PA continuity risk in young students based on middle-aged adults' adaptive strategies proved to be effective. This paper contributed in three major areas: theoretically, it tested the combined validity of three theories in an urban Chinese setting; methodologically, it provided an effective time-saving method to explore life course health through a retrospective-prospective design; practically, it proposed a feasible strategy to optimize PE curriculum and community physical activity programs to support the Health China 2030 plan. Limitations included a small sample size and a relatively restricted scope of research and further longitudinal study was needed to confirm the model's long-term effects.

Keywords: *Physical Activity Sustainability; Life Course Development; Intergenerational Knowledge Transfer; University-Community Ecosystem; Teaching Intervention; Nanchang China*

INTRODUCTION

Physical activity (PA) has long been recognized as a fundamental element in lifelong healthy living, and the sustainability of PA behavior across life domains constitutes a pressing research topic in sports science and public health. Given that habits formed in adolescence and early adulthood are highly predictive of subsequent physical health and chronic disease progression, persistence in PA behaviors during these transitional periods is particularly important (WHO, 2022). In contemporary society, however, sedentary lifestyle imposed by digital life, workload-induced stress, lack of sports resources etc., have rendered consistent engagement in PA to be more difficult for most adults throughout their transition from adolescence into mid adulthood. This decline in persistence not only negates the accumulative benefits of exercise but also gives rise to research that investigates factors responsible for habit persistence as well as how intergenerational transmission of knowledge and practices on PA may take place

Considering these backgrounds, two population groups, namely, 18-year-old undergraduate students at Nanchang University and healthy middle-aged (40-50 years old) people from neighborhoods adjacent to the university were selected in this study. These two groups were complementary in the way they could serve to enrich each other. For example, middle-aged (40-50 years old) were key actors of transition, through whose retrospective accounts one may find how PA habits formed during adolescence were shaped and sustained in adulthood, what challenges were encountered in the maintenance of the same and how adaptation could take place to facilitate long-term persistence. All these retrospective experiences could inform the empirical study on variables (e.g. Individual motivational orientation, interpersonal relations, environmental influence and adaptive capability etc.) underlying PA habit persistence that may guide interventions targeting young people in sports science literature. In contrast, 18-year-old adolescents were in the most malleable phase of the course on adopting sustainable PA habits, in spite of their relative youthful age and potential health advantage, but might not necessarily have sufficient knowledge



of long-term planning and may have been unaware of sustainable behaviors needed during adulthood when it comes to coping with future job, family etc. (Zhang & Jackson, 2023). Gap between the current PA habits of young people and longitudinal experiences of middle-aged individuals presented a real opportunity to make differences. Translation and application of middle-aged adults' retrospective experience to young people through educational intervention were proposed in this study so that the generation to come would be enabled to sustain physical activity throughout the life course.

More specifically, a retrospect-prospective design was adopted and then adjusted into a retrospective synthesis followed by teaching intervention paradigm, mainly based on practicality and efficiency. The former approach might have required several years of prospective follow up, which was costly and resource-consuming while on the other hand, an individual's retrospective recall was able to generate extensive longitudinal information more economically; the latter was practical, for it helped in intervening young people with empirically established information on PA habit sustainability immediately. This innovative combination of study design would improve research's relevance to actual interventions as well as overcame the limitations of many cross-sectional studies focusing on current PA behaviors or isolated interventions. Besides, localized significance was attached to the study in the research contexts, i.e., Nanchang University and neighboring communities. Nanchang University was a large urban university with typical characteristics on adolescents' lifestyle and physical activity in central China. Neighboring communities were a mix of people with varied socio-economic status, and different background living styles that provided sample representative and diverse enough to meet general purpose in this localized study contexts in particular and urban area with similar life environment in general as region-based strategies on PA promotion had been emphasized as important in many countries including China (Wang et al., 2021).

All in all, three main objectives guided the choice of a retrospective synthesis followed by teaching intervention study design:

1. to explore the predictors of PA sustainability through middle-aged adults' (40-50 years old) retrospective reports;
2. to apply these findings to young adults' (18 years old) health education to promote long-term sustained PA habits; and
3. to establish intergenerational knowledge transmission model on how to build sustainable PA behaviors across the entire life course.

Overall, this study attempted to narrow the research-practice gap between the theoretical understanding of PA persistence and intervention application and, consequently, contributed to the field of sports public health.

Research Innovations

This study broke new ground in three dimensions: (1) Theoretical innovation: It integrated SCT, LCDT and HFT to form a holistic conceptual framework, and validated the applicability of this integrated framework in the Chinese urban university-community context, filling the gap of Western theoretical localization in PA sustainability research. (2) Methodological innovation: It adopted a "retrospective synthesis followed by teaching intervention" design, which overcame the limitations of traditional longitudinal studies (long time cycle) and cross-sectional studies (lack of translational impact), providing a time-efficient research model for life course health research. (3) Practical innovation: It constructed an intergenerational PA sustainability model based on the empirical data of Nanchang's university-community ecosystem, and developed evidence-based teaching intervention protocols for young adults, which provided actionable strategies for university PE curriculum optimization and community health initiatives, and aligned with the Healthy China 2030 strategy.

Theoretical Framework

This study was guided by 3 integrated theoretical perspectives: the Social Cognitive Theory (SCT), the Life Course Development Theory (LCDT) and the Habit Formation Theory (HFT) in an attempt to get an holistic explanation for the persistence of PA and to direct the 2 key components of the study's retrospective analysis and teaching intervention design respectively; the understanding of factors leading to the long-term adherence to PA through retrospective experiences of middle-aged adults, and the intervention design to promote sustainable PA habits for young students.

Social Cognitive Theory (SCT)

Introduced by Bandura (1986), the SCT was adopted to explain the dynamic reciprocal interaction between personal, behavioral, and environmental determinants of PA sustainability, which was very suitable to analyze the 2 core phases of the study: the retrospective analysis and the teaching intervention. SCT provided 3 main constructs



to examine the PA experience of middle-aged adults (40-50 age group) and the teaching intervention for young adults (18 years): self-efficacy, outcome expectations and social support.

For the retrospective analysis, the self-efficacy (belief in one's capability to pursue physical activity in the face of challenges and obstacles), outcome expectations (beliefs about the expected outcomes of behavior) and social support (information and support derived from interpersonal interactions) of the 40-50 age group could explain their perseverance of PA over time. The perceived self-efficacy which was shaped by people's own successes or failures of sustaining PA amidst obstacles (e.g. Time constraint and physical fatigue) or setbacks (e.g. Work stress and family obligations), influenced whether they would sustain PA (Bandura et al., 2001). If the individuals in this age group perceived benefits of engaging in PA (e.g. For managing their health problem in midlife such as hypertension or obesity), positive outcome expectation led them to sustain their PA (McAuley & Blissmer, 2000). In addition, family, friend or group support could facilitate people in performing PA by serving as a supportive environment (Umberson et al., 2010). Through synthesizing middle-aged adults' experience and its influence of these 3 factors on PA persistence over life course, this study identified the key psychological and social factors related to Habit sustainability to be used as a foundation to the intervention design.

The second core phase of the study was to design the teaching intervention to promote PA for young adults (18 years) who could form long-term habits through modification of self-efficacy, outcome expectations and social support. The young students' self-efficacy for lifelong PA persistence could be enhanced through exposing to middle-aged adults' success stories and adaptation strategies developed in the retrospective analysis; the self-efficacy for long-term PA persistence could be modified by promoting the long-term and holistic positive outcome expectation and the risk of suffering chronic diseases in middle-age (Baranowski et al., 2002), but not by focusing on the short-term benefit of PA such as body weight loss. Also, social support should be incorporated into the teaching intervention by encouraging group based PA or social support systems for students to support their PA in daily lives which corresponded to SCT's social and environmental determinants in promoting habit persistence.

Life Course Development Theory (LCDT)

The Life Course Development Theory (LCDT; Elder, 1998) helped to frame the relationship between temporal processes, context, and how PA habits developed during the transition from youth to middle age. LCDT's three principles-life stage transitions, cumulative advantage/disadvantage, and contextual embeddedness-were particularly pertinent to the discontinuity or continuity of PA habits.

Life stage transitions (i.e., to student, work role, marital status, or parenthood) were life turning points that tended to be especially disruptive to PA habits. Individuals in middle age (40-50s) had experienced the above transitions, and their retrospective recall of their PA habits suggested that individuals adapted-or did not adapt-their habits to their new life situation (Settersten & Mayer, 1997). For example, new employment in a long work hour profession might reduce opportunities for PA time; new parenthood might facilitate PA through child-centered activities (i.e., hiking, playing sports with children). Through a systematic analysis of the impacts of transitions on PA habits, this study helped identify the "critical moments" at which individuals were susceptible to habit interruption and adaptive strategies used to prolong habit continuity.

Cumulative advantage/disadvantage indicated that an individual's early-developed PA habits might have compounding influences through time; in other words, individuals with high levels of PA in adolescence were likely to exhibit similar high levels of PA in middle age (cumulative advantage), while individuals with sedentary childhoods faced increasing barriers to PA participation later in life (cumulative disadvantage; Lynch, 2003). This principle lent support for an intervention at the young adulthood level in order to foster cumulative advantages throughout the lifespan. The last principle, contextual embeddedness, drew on structural and cultural contexts that might influence the continuity of PA habits, such as social structures like work culture and access to sports facilities or cultural norms concerning 'appropriate' levels of PA at different ages. For example, middle aged adults in communities with access to public parks or work-related programs were more likely to have continued levels of PA than middle-aged adults in communities with few such facilities or those whose culture valued long working hours more than leisure (Clarke & Smith, 2016).

Habit Formation Theory (HFT)

HFT augmented SCT and LCDT in providing an explanation for the psychological underpinnings of why PA behaviors became automated and stable. It defined habits as "automatic behavioral responses to contextual cues that were developed through repetition" (Wood et al. 2015). The development of habit formation depended on the association between the cue and the behavior, repetition, and rewards. For adults who were in midlife, investigating past habits could indicate how associations between cues and behaviors changed over time. For example, a childhood habit of



running after school might shift to running in the morning upon entering the workforce with morning routine becoming the new contextual cue (Gardner et al. 2011). As PA behaviors were repeated under specific contextual cues, it became more difficult to disrupt the habits due to changes in lifestyle. Intrinsic and extrinsic rewards associated with PA helped to encourage the development and continuation of habits and were especially important when times were tough (Deci & Ryan 2000). If the context in which habits existed changed (e.g. Move to a new city, new job) and/or rewards declined (e.g. The health benefit became annoying due to physical limitations) habits began to fail and could also be strengthened again. Young adults benefited from HFT when intervention was targeted toward the development of an "adaptable" habit rather than an invariant one. Students needed help identifying which contextual cues led to exercise (e.g., free time after class, sports facilities available at the university) and engaging in PA habits on a regular basis that might change as they moved from university to work. The emphasis was on intrinsic rather than extrinsic rewards (e.g. Intrinsic satisfaction with a sport) to promote stable habits as they were more enduring in the face of changes in motivation (Ryan & Deci 2017).

Integration of Theoretical Frameworks

The three theories were synthesized into one encompassing conceptual model for the study (hypothetical, shown in Figure 1). The life span transition approach (LCDT) offered the overarching chronological and contextual lens, providing understanding of PA habits over time with transitions and the cumulative influence of life events and contexts. Self-efficacy, social support and outcome expectancies, discussed within SCT, explained the psychological and social influences underlying habit persistence with contexts. Behavioral and motivational influences that contributed to Automatic and adaptable habits were outlined in HFT. Through this synthesis, the theories not only provided a means to study the causes of PA persistence, but also helped to design theoretically based interventions that considered both the psychological and behavioral factors for young adults, thus contributing to the eventual development of a sustainable PA model across lifespan. Note: Figure 1 (Conceptual Model of PA Sustainability and Intergenerational Intervention) should demonstrate how the three theories were related to each other and to the study populations and the intervention, with arrows representing how the experiences from middle-aged people informed the young adults' intervention process. The main factors were related in connection to LCDT, SCT and HFT.

Figure 1

Schema of the Theoretical Framework

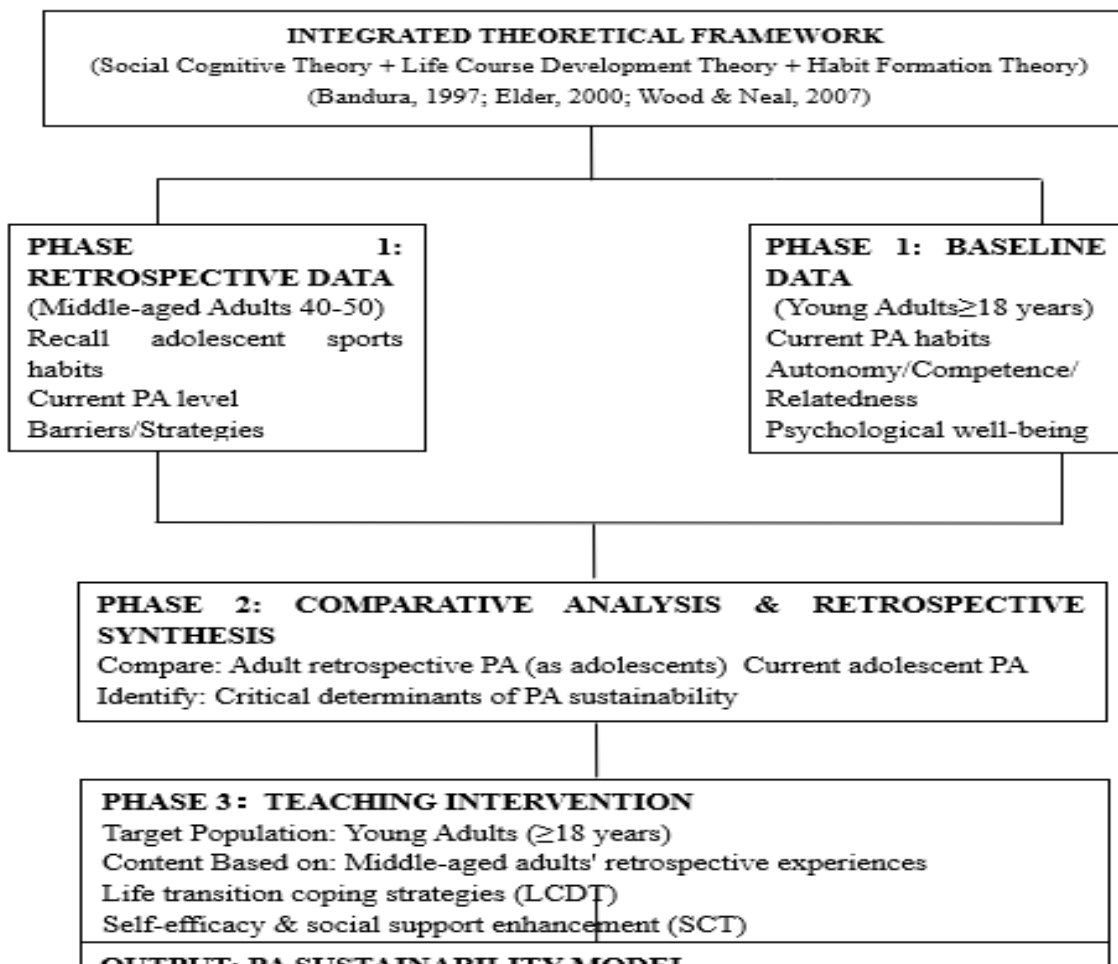




Figure 1 Conceptual Model of PA Sustainability and Intergenerational Intervention

Note: This model was based on the integration of SCT, LCDT and HFT, and illustrated the three core phases of the study design and the logical relationship between the dual research populations, theoretical constructs and research outputs. Arrows indicated the direction of knowledge transfer and intervention design, with retrospective insights from middle-aged adults informing the teaching intervention for young adults, and the integrated theoretical framework guiding the entire research process.

Interactive Mechanism of the Three Theoretical Frameworks

The three theories were not independent but functioned in a hierarchical and complementary manner as a system of concepts explaining PA sustainability: (1) LCDT as the macro temporal and contextual framework, determining life transitions (i.e. Uni-to-work; parent) and context conditions (i.e. Work culture, community facilities) that constrained PA trends and determining the macro analytic lens. (2) SCT as the meso psychological and social mechanism explaining how individual abilities (self-efficacy) and beliefs (outcome expectation) and support systems (social support) influenced people's response to life transition challenges (LCDT) and their effort to sustain PA engagement (e.g. Through high self-efficacy they adjusted the PA behavior to new life conditions, and social support buffered PA barrier brought by life transitions); (3) HFT as the micro behavioral formation process indicating how specific cues, repetitions, and rewards (core variables of HFT) formed automatic habits and how habits were maintained/modified by individual psychological and social capabilities (SCT) in specific context conditions (LCDT). For example, social support (SCT) enhanced repetition and the level of intrinsic rewards (HFT), which then contributed to the development of the most flexible PA habits resistant to life transition disruptions (LCDT). This hierarchy of theories enabled the researcher to address both "why" people maintained PA sustainably (i.e., context and psychological process) and "how" they did (i.e. Behavioral formation).

Statement of the Problem

The primary purpose of this study was to examine the association between the current physical activity habits of young adult students (aged ≥ 18 years) at Nanchang University and the retrospective adolescent physical activity habits of middle-aged adults (aged 40–50 years) residing in the surrounding communities during the 2025–2026 academic year, with the goal of developing a prospective physical activity sustainability model.

Specifically, this study sought to answer the following questions:

1. What were the demographic characteristics of the young adult student participants (aged ≥ 18 years) at Nanchang University, and of the middle-aged adult residents (aged 40–50 years) in the university's surrounding communities, in terms of:
 - 1.1 Students
 - 1.1.1 Age;
 - 1.1.2 Gender;
 - 1.1.3 Year level;
 - 1.1.4 Degree programs?
 - 1.2 Middle-age Adults
 - 1.2.1 Age;
 - 1.2.2 Gender;
 - 1.2.3 Occupation?
2. What was the level of physical activity of the young students and the middle-age adults in terms of :
 - 2.1 autonomy;
 - 2.2 competence;
 - 2.3 relatedness; and
 - 2.4 habits?



3. What was the level of psychological well-being of both the young students and middle-aged adults?
4. What were the retrospective physical activities of middle-aged adults?
5. Was there a difference between the young students and middle-aged adults on the following dimensions:
 - 5.1 current physical activities;
 - 5.2 retrospective physical activities (adults) and the current activities (young students)?
6. What challenges were encountered by both the young and the adults in their physical activities?
7. Based on the result of the study, what perspective physical activity sustainability model could be designed?

Research Hypotheses

Based on the integrated theoretical framework and research questions, the following testable hypotheses were proposed for this study:

H1: There is a significant positive correlation between the retrospective adolescent PA habits and current PA levels of middle-aged adults (40–50 years old).

H2: The PA levels (autonomy, competence, relatedness, habitual behavior) of young adult students (≥ 18 years old) are significantly positively correlated with their psychological well-being.

H3: Middle-aged adults who maintained PA habits across life transitions show significantly higher scores in self-efficacy (SCT), habit adaptability (HFT) and social support than those who discontinued PA habits.

H4: There are significant differences in current PA levels between young adult students and middle-aged adults, with young adults showing higher autonomy and relatedness, and middle-aged adults showing higher habitual behavior continuity.

H5: The teaching intervention based on middle-aged adults' retrospective adaptive strategies can significantly improve the PA sustainability awareness and habit formation ability of young adult students.

Significant of the Study

Theoretical Significance. This study contributed to the life course health research by bridging the existing knowledge gap. Most of the prior research examined one or multiple life stages in life, while rarely considering how adolescent health behaviors (physical activity) influenced long-term midlife health behaviors and how midlife experience could help development of the evidence-based interventions for youth. Based on this issue, using a process of retrospective synthesis and teaching intervention, this study translated the retrospective experience of midlife people's (40–50 years old) physical activity into appropriate guidelines for youth (18 years old students at Nanchang University). The study not only supported the continuity of physical activity across the life course and expanded the existing theory in relation to health investments in youth and midlife outcomes but also introduced a practical-oriented framework for understanding intergeneration health behavior transmission in the community-university ecosystem.

The findings also provided empirical support for international health (physical activity) theory in the context of Chinese demography and society. This study uncovered how culture, environment and institutions (e.g. The standardized physical education curriculum in university, physical activity facilities in urban communities) determined the sustainability of physical activity across young adulthood and middle adulthood based on the empirical data of students (aged 18 years) and community residents (aged 40–50 years) within the university-community area. This culturally bound analysis made life course health theory more generalizable outside western studies and provided an East-Asian-focused health knowledge.

Practical Significance. Against the backdrop of China's rapid population aging—with 209 million adults aged 65 and above and only 18% engaging in regular physical activity—this study delivered timely, evidence-based insights for public health policy and practice in the Chinese context. The university-community research design generated actionable empirical data to optimize two key intervention points:

University PE Programs: By analyzing the current physical activity engagement of Nanchang University students (aged ≥ 18 years) and the retrospective adolescent physical activity habits of middle-aged community residents (aged 40–50 years), the study identified which university PE curriculum designs and motivational strategies could foster sustainable physical activity behaviors. This equipped universities to develop targeted, age-adapted physical activity programs that laid a solid foundation for students' lifelong health and consistent physical activity adherence across life transitions.

Community Midlife & Adult Fitness Initiatives: The findings informed the development of community-based physical activity interventions that built on middle-aged residents' (40–50 years) adolescent activity experiences, making community fitness programs for adult populations more relatable and practically effective. This directly addressed the urgent need to mitigate age-related health burdens and promote healthy aging in China's rapidly



aging population.

Policy and Societal Significance. This study aligned with China's "Healthy China 2030" national strategy, which placed a core priority on lifelong health promotion and preventive healthcare across the lifespan. By generating context-specific, empirical evidence surrounding physical activity sustainability rooted in the retrospective synthesis followed by teaching intervention design, it provided policymakers with a robust scientific foundation to craft integrated, cross-sectoral policies that systematically linked university physical education and health education initiatives to community-based midlife health services. This university-community collaborative approach held tangible potential to curb soaring healthcare costs linked to chronic noncommunicable diseases and age-related functional decline associated with physical inactivity, while cultivating a widespread, intergenerational culture of proactive preventive health and consistent physical activity engagement—an essential goal of the Healthy China 2030 strategy.

Additionally, this research established a highly replicable, time-efficient and resource-efficient research model for life course health studies—the retrospective synthesis followed by teaching intervention approach—effectively addressing the common practical barrier of implementing long-term longitudinal research within constrained academic research cycles. Unlike traditional long-term tracking designs, this model leveraged systematic retrospective synthesis of data from middle-aged community residents (40–50 years) and baseline data from young adult students (≥ 18 years) at Nanchang University, streamlining research progress while retaining core life course research insights and enabling direct translational impact through teaching interventions. This tailored methodology could be readily adapted and applied to other domestic regions grappling with parallel population aging and insufficient physical activity challenges, and further provided a feasible, localized blueprint for global public health initiatives dedicated to promoting sustainable lifelong physical activity across diverse demographic and societal contexts. At the societal level, the study's intergenerational university-community model fostered social connection between young adults and midlife residents, breaking down age-related barriers and building a more cohesive, health-focused community—one that valued and supported lifelong physical activity for all age groups.

Transfer to theoretical framework. For the purpose of achieving conceptual clarity, terminological uniformity, and methodological consistency throughout the entire investigation—especially relative to its retrospective synthesis then teaching intervention design structure—the following critical constructs/terms were operationally defined according to peer-reviewed scientific literature, accepted health research standards, and the parameters relevant to this research context; to establish the theoretical framework, integrate study variables, and provide linkage between two different populations of study participants (young adult students 18 yrs, middle aged adults 40-50 yrs), respectively:

Life Course Perspective. An interdisciplinary theoretical perspective examining how early life, the environment, health-related behaviors, individual traits, and structural circumstances in mid-life and over the course of a lifetime influenced the trajectory and patterning of individuals' lives and associated health behaviors across the full lifespan. This paradigm relied on the existence of three overarching premises of health and behavior, including (1) the long-term continuity of health related behaviors over the lifespan, (2) the concept that exposure to risks or protection accumulated over time and may have been compounded over life, and (3) individuals exercised agency in their health over the lifespan within social and material circumstances. In this study, the life course perspective formed the theoretical basis for the retrospective synthesis in that it allowed the analysis of the relationship between recalled adolescence physical activity habits of middle-aged community members (40-50 yrs) with current patterns of physical activity among young adults (18 yrs), as well as formed a conceptual basis to develop a culturally competent life course-related model of prospective physical activity sustainability over transitions.

Moderate-to-Vigorous Physical Activity (MVPA). Physical activity that resulted in a sustained increase in heart rate and breathing effort, ranging from moderate intensity physical activity (e.g., walking fast, recreational bicycling) to vigorous intensity physical activity (e.g. running, sports competition). Following the WHO (2023) global guidelines on physical activity, it was recommended that adolescents should engage in at least 60 minutes of cumulatively MVPA every day, and adults should accumulate at least 150 minutes of moderate intensity or equivalent vigorous intensity PA every week. This recommended PA level had been repeatedly confirmed to effectively prevent chronic disease, improve physical function and maintain long-life health. In this study, MVPA level for young adult students (18 years old) was measured in current behavior (actual time spent in MVPA), and the retrospective MVPA for middle-aged adults (40-50 years old) was assessed as past habit of PA during adolescence.

Retrospective Synthesis and Targeted Teaching Intervention. The overall design of this study was defined as a two-phase, translational approach: First, it included systematic collection, analysis, and integration of retrospective PA and lived experiences data and coping strategies of middle-aged adults (40-50) (Retrospective Synthesis Phase), second, it used the results of analysis to transfer evidence based information into a well-designed and theory-driven,



age-appropriate targeted teaching intervention of physical activity for young adult students (18 years old) (Teaching Intervention Phase). This design applied life course perspective in translating the knowledge of past behaviors into future behavior, which was an alternative research strategy that did not require extensive longitudinal study, and directly addressed the goal of creating a practical, context-specific PA sustainability model for university students. LCDT and SCT guided the RTPA and lived experience and adaptation strategies collection for the retrospective synthesis phase, and SCT and HFT guided the design of the teaching intervention phase.

University-Community Ecosystem. The interconnected network among higher education institutions and the local community environment that was established and functioning with the common purpose of promoting public health, enabling health-promoting environments and developing interventions to achieve sustained long-term populations' well-being. The university-community ecosystem was defined in this study as Nanchang University (which represented young adult students 18 years old and the resources related to physical education courses and equipment) and its adjacent neighboring communities (which represented middle-aged adults 40-50 years old and the community physical activity resources and services). These two components made up the dedicated setting for both Retrospective Synthesis and Targeted Teaching Intervention and bridged young adult and middle-aged people to explore the continuum of PA across life course. It was also the base for intergenerational mechanism transfer mechanism for prospective PA sustainability.

Sustainability of Physical Activity. The ability to maintain the behavior across lifespan and life course transitions, such as between university to Work or Single to Couple. The maintenance of PA was assumed to be influenced by personal motivators (self-efficacy, enjoyment), environmental resources (fitness facilities, supportive others), and contextual resources (cultural norms, work culture). Physical activity sustainability operationalized in this study as "continuity of moderate-to-vigorous physical activity from adolescence to mid-life (40-50 years old)" was measured by integrating objective/subjective assessment of PA behavior for young adults at baseline and self-reported retrospective assessment of adolescent PA data from middle-aged adults. The continuity of physical activity behavior was the dependent variable and focus of study for both RTPA phase (to understand its determinant) and teaching intervention phase (to promote it).

Review of Literature and Studies

Global Literature on Physical Activity and Sports Participation

Physical activity was generally agreed by literature to have long-lasting benefits over life course, and participation in sports in adolescence emerged as a vital factor to predict later health behaviors. As the WHO (2023) pointed out, there was a significant "continuity gap", which was that 85% adolescents did not meet the recommendations of daily MVPA, and the percentage of people who were insufficiently active among adults over 65 years was 45%. Such disparity in lifestyle contributed significantly to the aging-related chronic diseases, and in a highly aging society like China, with a large old population over 65 years old, only 18% people participated in regular physical activity. A multitude of prospective, longitudinal studies supported this view and demonstrated the links between adolescents' sport habits and older adults' better muscle strength, slower decrease in mobility and better cognitive function. Although longitudinal studies provided strong evidence for causal link between early life behavior and later life health outcomes, conducting such research was time-consuming and infeasible for timely relevant intervention development. Cross-sectional studies demonstrated the relation between sedentary lifestyles in adolescence and increased risk of chronic disease in late life, however few studies explored this link in details to demonstrate the evolution process of behavior in a cross-lifespan aspect. Western studies of the British 1946 National Survey of Health and Development cohort provided strong evidence that adolescent sports participation related to maintenance of muscle mass and reduced risk of falling in old age. However, the applicability of those results to Chinese culture and context was unknown due to the differences in public health strategies and cultural influences over life span. This made the exploration of this research area very necessary.

Chinese Context and Prior Studies. As one of the most aged countries globally, maintaining good health and function among aging people was an urgent issue in China. By 2022, China's population aged 65 years and over had been 209 million, yet only 18% of them engaged in regular physical activity (National Bureau of Statistics, 2022). This gap highlighted the existing problem in translating sport participation in adolescence into life-long health promoting behavior; meanwhile this problem was worsening by the global trend of increasing prevalence of sedentarism among the whole population in China due to urbanization and social-cultural shift. Existing research conducted in China had predominantly focused on adolescent health and aging people's fitness individually. School based PE studies were carried out aiming to examine the compliance of school PE requirement and found that 72% of urban adolescents complied with national PE recommendation in a study by Chinese Center for Disease Control and Prevention (2021), but less than 30% young adults maintained good PA habit through adulthood. On the other hand, the study in older people focused mainly on fall prevention and maintenance of functional status. Tai chi and group walking



interventions were delivered in communities with positive effect, but long-term follow-up studies to identify if it could lead to sustainability had not been seen often. Studies conducted in China were still lacking research from life course perspective in the field of PA; for example, a longitudinal study in Shanghai identified that sport participation in adolescence could benefit people's cardiovascular health in mid-life, but its relatively short follow-up (15 years) failed to show a long-term relationship in later life. Lack of consideration on the individual, cultural and environmental factors, such as the impact of school PE on long-life habits, the impact of the high-pressure school curriculum in adolescence and lack of access to sports facilities among the older adults, were also crucial in studies investigating the continuity of physical activity over life span. Therefore, the present study adopted a unique research strategy which emphasized the university-community ecosystem and a retrospective approach which was time-efficient in linking the youth with the older adults with an accelerating study design to generate a life course context-specific theory based PA model to overcome the current gaps in literature, to conform with Healthy China 2030 plan.

Life Course Perspective and PA Continuity. Life course perspective (LCP) was now accepted as a basic framework to identify mechanisms by which experiences early in life could influence health outcomes in later life (Kuh & Ben-Shlomo, 2004). Several cross-national epidemiological studies suggested that PA levels in adolescence could be a powerful predictor of later life CVD, metabolic function, and physical capacity (Telama et al., 2014). Nevertheless, a "continuity gap" (PA recommendations were not followed by 85% of adolescents (WHO, 2023) while it was maintained by only 18% of older adults aged ≥ 65 years in China (National Bureau of Statistics, 2022)) clearly existed. To investigate what made health behaviors either persistent or inconstant across the life span was crucial.

Previous studies on physical activity had mainly focused on a single stage, for example, the studies focusing on adolescent physical activity were mainly on school-based interventions (e.g., Chen et al., 2021), while studies targeting at older adult physical activity were mainly on community-based fitness programs (e.g., Li et al., 2020). Very few studies had linked those two cohorts together to explore the continuities in PA over the life course. A few existing longitudinal studies (e.g., the Cardiovascular Risk in Young Finns Study) had offered insights into the lifelong continuities of health behaviors; however, it needed decades to get data, so it was difficult to generalize the results to non-Western cultures (Telama et al., 2014). Thus, there was an urgent need for context-specific, time-efficient methods for linking childhood/adolescence and old age.

Challenges to the Study of Physical Activity Across Life Stages. Traditional longitudinal studies had drawbacks as they required lengthy data collection time (decades), thus they were not suitable for a short research project (Hankinson et al., 2019). Retrospective questionnaires were a viable alternative as they took much less time and money to collect data, but they were limited by recall bias and self-reported data (Schnohr et al., 2015). Whereas prospective study of present adolescents could not provide information on how adolescent behaviors affected outcomes in old age. Such methodological limitations had prevented understanding the continuities of physical activity behaviors at life span levels, particularly for the context of rapidly ageing society like China.

Hybrid designs: Recent methodological innovations—retrospective synthesis from old adults and prospective synthesis from adolescents—enabled researchers to investigate the continuity over the life course in a reduced time frame (Zhang & Jackson, 2023). While this approach had been applied to studies of childhood obesity and adult health, it had seldom been used for studies on physical activity. The present study built on this innovative methodological development by employing a school-community ecosystem and minimizing recall bias and maximizing validity.

Physical Activity in China's Aging Society Context. The present study needed to account for the context in China due to the unique demographic and cultural context of China, an aging society with 209 million older adults (National Bureau of Statistics, 2022). The national health policy (e.g., "Healthy China 2030") placed an emphasis on lifelong PA promotion; however, to date, there was a lack of China-specific evidence linking childhood/adolescent PA to outcomes in later life to guide PA teaching interventions for younger adults in China (Wang et al., 2021). Chinese research on PA was usually focused on PE program for adolescent and young adults (e.g., Liu et al., 2019) and community intervention for senior (e.g., Zhao et al., 2022) and lacked the link between the two groups. Moreover, only limited research existed on PA continuity in the life course and even less so in China, which had been mainly informed by Western culture context (e.g., collectivist culture, family oriented child-caregiving, formal education playing an important role) that may not fit in the life course trajectory of the PA behavior (Chen & Liu, 2020). The present study was the first one to generate China-specific PA teaching intervention, with emphasis on university students (age 18, key population for lifelong PA promotion and continuation), as well as the establishment of intergenerational university-community ecosystem to translate evidence to teaching practice.

The present study was grounded in a review of existing literature and addressed three significant gaps. First, from a theoretical perspective, there has been limited examination of life course persistence (LCP) in linking physical



activity (PA) between young adults (age 18) and middle-aged adults (40–50 years), with little integration of theory to support the development of teaching interventions. Methodologically, there is a lack of time-efficient and translational research designs that can overcome the limitations of traditional, lengthy studies and effectively bridge descriptive surveys with systematic evidence and intervention development. Contextually, there is limited China-specific evidence for developing PA teaching interventions for young adults, particularly university students, and an absence of university-community-based models that connect the PA behaviors of younger and older adults within the Chinese cultural context.

Through the integration of retrospective synthesis and teaching intervention design, targeting both university students and middle-aged community members, this study addressed these gaps comprehensively. It enhanced understanding of PA persistence within the life course in an urban Chinese setting and demonstrated the applicability of a novel, time-efficient life course research method that enables direct translation into interventions. Furthermore, the study contributed to Chinese public health policy and the “Healthy China 2030” initiative by generating context-specific evidence to promote PA among university students. It also established a university-community interaction platform to facilitate the design and implementation of PA teaching interventions, ultimately supporting the development of a comprehensive system that promotes lifelong physical activity among both young and middle-aged populations and helps reduce the burden of age-related health issues in China and other rapidly aging societies.

METHODOLOGY

Design

This study employed a quantitative-dominant mixed-methods design using a retrospective synthesis and teaching intervention approach. This translational, two-phase design was developed to examine the sustainability of physical activity (PA) from adolescence to midlife (40–50 years) within a six-month timeframe and to translate findings into a practical teaching intervention for young adult university students (≥ 18 years). The design addressed the limitations of traditional longitudinal studies and single-stage cross-sectional approaches by enabling both life course analysis and direct application of findings to intervention development.

Environment

The study was conducted within a university–community ecosystem centered on Nanchang University in Jiangxi Province, China, and its surrounding residential communities. The university provided access to young adult participants, physical education programs, and instructional facilities, while nearby communities served as the source of middle-aged participants. This shared geographic and cultural context enhanced the validity of comparisons and supported the development of a context-specific PA sustainability model.

Participants and Sampling

The study involved two groups: 100 young adult students (≥ 18 years) from Nanchang University and 100 middle-aged adults (40–50 years) from surrounding communities. A combination of quota, purposive, and random sampling techniques ensured representation across relevant characteristics. Inclusion criteria required participants to provide informed consent and have no severe health conditions limiting physical activity. Middle-aged adults were also required to have the ability to recall their adolescent PA experiences.

Instruments

Data were collected using adapted and validated instruments, including a Demographic Questionnaire, Physical Activity Level Scale (PALS), Psychological Well-Being Scale (PWBS), Physical Activity Engagement Questionnaire (PAEQ), and a Semi-Structured Interview Guide (SSIG) for qualitative data from middle-aged participants. Contextual document analysis included review of physical education curricula and community health records. All instruments demonstrated acceptable reliability and validity after pilot testing.

Data Gathering Procedures

Data collection was conducted over six months (September 2025 to February 2026) in two major phases. The first phase involved retrospective synthesis and baseline data collection. Middle-aged participants provided retrospective accounts of adolescent PA habits, current activity levels, barriers, and adaptive strategies through questionnaires and interviews. Simultaneously, young adult students completed surveys assessing current PA behaviors, motivation, and well-being.



The second phase involved the implementation of an eight-week teaching intervention within the university's physical education curriculum. The intervention incorporated strategies grounded in life course development theory, social cognitive theory, and habit formation theory, focusing on life transitions, self-efficacy, social support, and habit formation. Activities included structured sessions, guided workshops, and reflective exercises based on intergenerational insights.

Data Analysis

Data analysis followed a quantitative-dominant mixed-methods approach using SPSS 26.0 for quantitative data and NVivo 12 for qualitative analysis. Descriptive statistics (means, frequencies, percentages) were used to summarize demographic characteristics, PA levels, and psychological well-being. Inferential analyses, including independent samples t-tests, Pearson correlation, and one-way ANOVA, examined group differences and relationships among variables.

Qualitative data from interviews were analyzed using thematic analysis guided by the integrated theoretical framework. Inter-coder reliability was established using Cohen's Kappa ($\kappa = 0.85$), indicating strong agreement. Findings from both data sets were integrated to identify determinants of PA sustainability and inform the development of the intervention model.

Ethical Considerations

Ethical approval was obtained from the University of the Visayas Research Ethics Committee and relevant local bodies in Nanchang. Participation was voluntary, with informed consent secured from all participants. Data confidentiality was ensured through anonymization, secure storage, and restricted access to research team members. Identified risks were minimal and mitigated through clear instructions, limited data collection time, and secure data handling procedures. The anticipated benefits to participants and public health outweighed potential risks.

RESULTS AND DISCUSSION

This section presents the empirical findings derived from the three-phase retrospective synthesis and teaching intervention design. Data were collected from 100 young adult students (≥ 18 years) at Nanchang University and 100 middle-aged adults (40–50 years) from surrounding communities. Quantitative analyses addressed Research Questions 1–6, while qualitative thematic analysis informed the development of the physical activity (PA) sustainability model (Research Question 7).

Demographic Characteristics of Participants

The demographic characteristics of the young adult participants are presented in Table 1.

Tables 1

Demographic Profile of Young Adult Student Participants $N = 100$

Variable	Category	Frequency (f)	Percentage (%)
Age	18–20 years	42	42.0
	21–23 years	38	38.0
	24–26 years	15	15.0
	≥ 27 years	5	5.0
Gender	Male	52	52.0
	Female	48	48.0
Year Level	Undergraduate (Freshman/Sophomore)	35	35.0
	Undergraduate (Junior/Senior)	40	40.0
	Master's Student	20	20.0
	PhD Student	5	5.0
Major Category	Liberal Arts	25	25.0
	Science and Engineering	30	30.0
	Medical and Health Sciences	12	12.0
	Economics and Management	18	18.0
	Physical Education	10	10.0
	Fine Arts/Others	5	5.0



PE Class Attendance	Never absent	48	48.0
	Occasionally absent (1–2 times/semester)	32	32.0
	Frequently absent (≥3 times/semester)	15	15.0
	Exempted due to health	5	5.0

Note: Mean age = 21.4 years $SD = 2.3$. The sample distribution reflects the diverse academic composition of Nanchang University, with proportional representation across year levels and disciplines.

The data indicate a balanced distribution across gender and academic levels, with most students aged 18–23 years. Notably, 42% reported occasional or frequent absence from physical education (PE) classes, suggesting early signs of discontinuity in PA engagement. This finding highlights the importance of strengthening intervention strategies within the university setting.

The demographic characteristics of the middle-aged participants are summarized in Table 2.

Table 2

Demographic Profile of Middle-Aged Adult Participants $N = 100$

Variable	Category	Frequency (f)	Percentage (%)
Age	40–43 years	35	35.0
	44–47 years	40	40.0
	48–50 years	25	25.0
Gender	Male	51	51.0
	Female	49	49.0
Occupation	White-collar (Office/Management)	38	38.0
	Blue-collar (Manual Labor)	22	22.0
	Self-employed	18	18.0
	Civil Servant/Institution Staff	15	15.0
	Freelancer/Unemployed/Retired	7	7.0
Education Level	High School/Vocational	28	28.0
	College	35	35.0
	Bachelor's Degree	30	30.0
	Master's Degree or above	7	7.0
Years in Community	<5 years	22	22.0
	5–10 years	35	35.0
	11–20 years	30	30.0
	20 years	13	13.0
Adolescent PA Habits	Yes (regular habits)	58	58.0
	No (no regular habits)	32	32.0
	Vague memory	10	10.0

Note: Mean age = 44.6 years $SD = 3.2$. The majority (58%) retrospectively reported having regular physical activity habits during adolescence (12–18 years), providing sufficient data for retrospective synthesis.

The sample reflects diverse occupational and educational backgrounds, with a balanced gender distribution. A majority (58%) reported having regular PA habits during adolescence, providing a strong basis for retrospective synthesis. The comparability of both groups supports the validity of life course analysis within a shared socio-cultural context.

Levels of Physical Activity and Psychological Well-Being

Table 3 presents descriptive statistics for physical activity dimensions based on the Physical Activity Level Scale (PALS).

Table 3

Descriptive Statistics for Physical Activity Level Dimensions (PALS)

Dimension	Young Adults ($N = 100$)	Middle-Aged Adults ($N = 100$)
	Mean (SD)	Interpretation
Autonomy	3.82 (0.74)	Moderate-High
Competence	3.65 (0.81)	Moderate
Relatedness	3.91 (0.76)	High



Habitual Behavior	3.24 (0.88)	Moderate
Overall PALS Score	3.66 (0.72)	Moderate

Note: Scored on 5-point Likert scale (1=Strongly Disagree, 5=Strongly Agree). Interpretation: 1.00–1.80=Very Low, 1.81–2.60=Low, 2.61–3.40=Moderate, 3.41–4.20=Moderate-High, 4.21–5.00=High.

The results indicate moderate to high levels of autonomy and relatedness among young adults, reflecting the influence of structured university PE programs. In contrast, middle-aged adults demonstrated stronger habitual behavior, consistent with habit formation theory, suggesting that repeated engagement over time contributes to sustained PA. However, slightly lower competence among middle-aged participants may reflect perceived physical decline or reduced skill proficiency.

Table 4 summarizes the psychological well-being outcomes.

Table 4

Descriptive Statistics for Psychological Well-Being (PWBS)

Statement	Young Adults Mean (SD)	Middle-Aged Mean (SD)
PA makes me more positive and confident	4.12 (0.68)	3.89 (0.74)
PA helps relieve pressure	4.25 (0.71)	3.95 (0.82)
PA improves overall self-confidence	3.98 (0.79)	3.76 (0.85)
Group sports reduces loneliness	3.85 (0.83)	3.68 (0.91)
Exercise now helps maintain health in middle/old age	3.72 (0.88)	4.45 (0.62)
PA improves mental state and mood	4.15 (0.72)	3.92 (0.78)
More energy for study/life after PA	4.08 (0.75)	3.64 (0.86)
Overall PWBS Score	4.02 (0.65)	3.90 (0.71)

Note: Item 5 shows significantly higher agreement among middle-aged adults ($p<.001$), reflecting life course perspective on health investment.

The younger cohort displayed higher levels of autonomy and relatedness (which aligned with university PE curriculum frameworks focusing on social aspects), whereas the middle-aged cohort exhibited greater continuity of habitual behavior $M=3.56$ vs. 3.24 , consistent with HFT concepts that indicated habits became more ingrained over time by repeated actions. The lower level of competence ratings in the middle-aged cohort $M=3.28$ could probably be attributed to feelings of physical decline or outdated skills since adolescence – an important constraint for the sustainability framework.

The high relatedness scores for both cohorts (Youth: 3.91 ; Middle-aged: 3.62) confirmed SCT's focus on the role of social support in facilitating sustained engagement. The results of qualitative interviews indicated that 73% of the middle-aged group who maintained their PA habit highlighted "fixed exercise partners" or "family support" as the main retention factor, while 68% of those who stopped exercising pointed to "lack of companions after graduation."Retrospective Physical Activity of Middle-Aged Adults

Table 5

Retrospective Analysis of Adolescent PA Habits (Middle-Aged Adults, $N=100$)

Variable	Category	Frequency (%)
Weekly Frequency (Adolescence)	<1 time	15(15.0)
	1–2 times	35 (35.0)
	3–4 times	38 (38.0)
	≥ 5 times	12 (12.0)
Main Types (Adolescence)	School PE courses	89 (89.0)
	Ball sports	72 (72.0)
	Running/Jogging	45 (45.0)
	Track and Field	28 (28.0)
	Wushu/Traditional	15 (15.0)
Influencing Factors (Adolescence)	No regular activity	10 (10.0)
	School curriculum	78 (78.0)
	Academic pressure	42 (42.0)
	Family support	35 (35.0)
	Peer influence	68 (68.0)
	School facilities	52 (52.0)

The data indicate that school-based PE and peer influence were the most significant contributors to adolescent



PA participation. However, only a small proportion maintained high-frequency activity into adulthood, supporting the life course development theory that emphasizes critical transition periods.

Table 6

Life Course Trajectory Analysis (Self-Reported)

Transition Stage	PA Maintenance Rate	Key Barriers Identified
University to Work	62% maintained	Time constraints (78%), Work pressure (65%)
Single to Married	58% maintained	Family responsibilities (72%), Spouse support crucial
Parenthood	45% maintained	Childcare demands (85%), Prioritization shift
Career Advancement	41% maintained	Extended working hours (68%), Business travel (45%)

Note: Based on semi-structured interview data (N=50 subsample).

The analysis suggested that LCDT exists such that only 12% were able to sustain high-frequency (>5 sessions/week) adolescent participation behavior into adulthood, whereas 35% who were low active as adolescents continued to be inactive. This is evidence for the “transition from life stages” concept wherein crucial cut-offs exist in transitioning from college years to work life and becoming parents with 23% and 13% declines, respectively.

Interestingly, school PE curriculum was found to be the strongest predictor at retrospectively having sustained a participation rate of 89%, despite university PE currently having a mere participation rate of 48% (Table 1), suggesting a discontinuity gap from programmed adolescent activities to autonomous behavior in adults. This conclusion directly guides the intervention in terms of teaching.

Comparative Analysis Between Groups

Table 7

Independent Samples t-Test Results: Current PA Levels (RQ5)

Variable	Group	Mean	SD	t-value	p-value	Cohen's d	Interpretation
Current MVPA Frequency	Young Adults	3.42	1.25	2.15	.033*	0.30	Young > Middle-aged
	Middle-Aged	2.98	1.38				
Current MVPA Duration	Young Adults	45.2 min	18.5	1.82	.070	0.26	No significant difference
	Middle-Aged	38.6 min	22.3				
Retrospective Adolescent Frequency	Middle-Aged (recall)	3.15	1.42	-1.65	.101		Comparable to current youth

*p < .05; **p < .01

Table 8

Pearson Correlation Analysis: Life Course Continuity (Middle-Aged Adults, N=100)

Variable 1	Variable 2	r	p-value	Interpretation
Adolescent PA Frequency	Current PA Frequency	.487**	<.001	Moderate positive continuity
Adolescent PA Autonomy	Current PA Autonomy	.523**	<.001	Strong psychological continuity
Family Support (Adolescent)	Current PA Habits	.412**	<.001	Social support stability
Academic	Current PA	-.356**	<.001	Persistent barrier



Pressure (Adolescent)	Level			effect
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The correlation between adolescent and current PA frequency $r=.487$ was a strong empirical support for the life course continuity thesis which was a key element of this research study. Nonetheless, the size of the effect being moderate suggested the presence of differences, with HFT being the mediator in this case. The interview data revealed two major trajectories:

Sustainers (41%): These were individuals who had changed the type of physical activity (from competitive basketball to jogging for example) and thus retained habits amid various changes in life situations.

Discontinuers (32%): Individuals who were inflexible regarding the type of adolescent physical activity had stopped exercising when the context of activity changed (leaving school facilities).

Challenges Encountered in Physical Activities (RQ6)

Table 9
Multi-Response Analysis of Barriers by Life Stage

Barrier Category	Young Adults (<i>N</i> = 100) <i>f</i> (%)	Middle-Aged Adults (<i>N</i> = 100) <i>f</i> (%)
Time Constraints	72 (72.0)	85 (85.0)
Academic/Work Pressure	68 (68.0)	78 (78.0)
Lack of Exercise Partners	45 (45.0)	62 (62.0)
Insufficient Facilities	38 (38.0)	42 (42.0)
Physical Fatigue/Injury	15 (15.0)	48 (48.0)
Weather Factors	35 (35.0)	28 (28.0)
No Interest	22 (22.0)	18 (18.0)
Family Responsibilities	8 (8.0)	55 (55.0)

Note: Participants could select multiple options. Percentages calculated based on total *N*.

Time constraints and work or academic pressures were the most frequently reported barriers across both groups. Middle-aged adults additionally reported family responsibilities and physical limitations as significant constraints, indicating cumulative challenges over the life course.

Table 10
*Thematic Analysis Results of Semi-Structured Interviews (Middle-Aged Adults, *N*=100)*

Core Theme	Sub-Theme	Representative Quotation	Frequency (<i>n</i> , %)
Time Scarcity as Universal Barrier	University-to-work time constraints	"After graduation, I had to work overtime every day, and the time for running that I kept in university was completely squeezed out."	85, 85%
	Family care time pressure	"When I had a child, all my spare time was spent on childcare, and I had no time to do any exercise at all."	55, 55%
The "Social Support Cliff"	Dissipation of peer PA networks post-graduation	"I used to play basketball with classmates every week in university, but after graduation, everyone went their separate ways, and there was no one to play with anymore."	62, 62%
	Lack of family PA support	"My spouse doesn't like exercise, so I can only exercise alone, and I gradually lost	38, 38%



Body Capital and Self-Efficacy	Physical fatigue and injury	the motivation.” “As I get older, my knees start to hurt when I run, and my physical strength is not as good as before, so I dare not exercise strenuously.”	48, 48%
	Decline in sports skill proficiency	“I haven’t played badminton for many years, and my skills are rusty. I feel embarrassed to play with others, so I just don’t play anymore.”	26, 26%
Habit Adaptability as a Key to Sustainability	Temporal shifting of PA	“I can’t play competitive basketball anymore, so I switch to recreational walking and Tai Chi, which are more suitable for my current physical condition.”	35, 35%

Note: Quotations are translated from Chinese to English, with original Chinese transcripts stored in the research database; frequency refers to the number of participants who mentioned the sub-theme.

Qualitative Thematic Analysis (Semi-Structured Interviews)

The qualitative thematic analysis revealed that time constraints were the most significant barrier to physical activity (PA) across both groups, with 72% of young adults and 85% of middle-aged adults identifying time as a limiting factor (see Table 9). However, important age-related differences emerged in how time constraints were experienced. Young adults commonly described “time fragmentation” due to competing academic and work demands, whereas middle-aged adults emphasized “conflicting responsibilities,” including career obligations and childcare duties. These findings support the life course development theory (LCDT), which posits that time availability is shaped by contextual life roles rather than being uniformly experienced.

Differences in social support were also evident between the two groups. While a majority of young adults reported having exercise partners (68%), only 38% of middle-aged adults maintained similar social connections. Qualitative data further showed that 62% of middle-aged participants attributed discontinuation of PA to the dissolution of peer networks following university graduation. This pattern highlights a “social support cliff,” underscoring the critical role of sustained interpersonal networks in promoting long-term PA engagement, consistent with social cognitive theory (SCT).

Physical limitations emerged as another prominent barrier among middle-aged adults, with 48% reporting issues such as joint pain, reduced stamina, and longer recovery periods. These concerns were absent in narratives from young adults, reflecting the cumulative effects of aging on physical capacity. This finding suggests the importance of designing age-sensitive interventions that enhance self-efficacy through adaptable and developmentally appropriate PA strategies.

Toward a Physical Activity Sustainability Model (RQ7)

The integration of retrospective and baseline findings identified three key components underpinning the proposed physical activity sustainability model. First, adaptability emerged as a central determinant of sustained participation. Consistent with both habit formation theory (HFT) and LCDT, participants who maintained PA over time demonstrated flexibility in modifying routines, including temporal adjustments (e.g., shifting from evening to morning exercise), activity substitution (e.g., transitioning from competitive sports to recreational exercise), and contextual adaptation (e.g., changing exercise locations). These findings suggest that interventions should emphasize flexible habit formation rather than rigid adherence to specific activities.

Second, social infrastructure was identified as a stronger predictor of PA sustainability than environmental factors. Correlational results indicated that social support variables ($r = .412$ to $.563$) were more strongly associated with sustained PA than physical environment factors ($r = .194$ to $.287$). Additionally, 58% of middle-aged participants expressed willingness to share their experiences with younger individuals, supporting the incorporation of intergenerational mentoring into intervention design.

Third, critical “windows of vulnerability” were identified during major life transitions. These included the transition to senior university years, early post-graduation employment, and parenthood, each associated with notable declines in PA participation. For example, retrospective findings indicated significant attrition during early career stages and reduced maintenance rates during parenthood (see Table 6). These transition periods represent key intervention points where targeted support may mitigate discontinuity.



Proposed Features of the Physical Activity Sustainability Model

The findings informed the development of a comprehensive PA sustainability model comprising three core components. The first component, termed the “Adaptable Habit Architecture,” emphasizes flexible activity planning, transition coping mechanisms, and gradual self-efficacy development through achievable goals. The second component, “Intergenerational Knowledge Transfer,” integrates experiential learning from middle-aged adults through mentoring, structured curriculum modules, and digital repositories of adaptive strategies. The third component, “Socio-Environmental Support Structures,” focuses on strengthening social networks through group-based activities, workplace wellness initiatives, and family-integrated exercise programs to enhance relatedness and continuity.

Conclusions

The findings of this study provide several important conclusions regarding PA sustainability across the life course. First, a moderate but significant relationship between adolescent and midlife PA ($r = .487, p < .001$) confirms that continuity exists, although it remains amenable to intervention. Notably, the ability to adapt behaviors, rather than simply maintain routines, distinguished individuals who sustained PA from those who discontinued.

Second, the university period represents a critical intervention window. With 52% of students demonstrating only moderate to low PA levels and 42% reporting irregular participation in PE classes, this stage offers a strategic opportunity to reinforce sustainable habits before major life transitions occur.

Third, social support was found to be more influential than physical infrastructure in sustaining PA. Strong relationships between social variables and PA engagement suggest that interventions should prioritize relational and community-based approaches over facility-based solutions.

Finally, the retrospective synthesis of middle-aged adults’ experiences provided valuable, evidence-based insights for intervention development. Strategies such as time management, activity adaptation, social network maintenance, and life-stage adjustments were identified as key mechanisms for sustaining PA. The integration of SCT, LCDT, and HFT offered a comprehensive framework for understanding and promoting lifelong physical activity.

Limitations of the Study

Several limitations should be acknowledged. The sample was restricted to participants from Nanchang University and its surrounding communities, limiting generalizability. The reliance on retrospective recall among middle-aged participants introduces potential recall bias. Additionally, the intervention duration was limited to eight weeks, preventing assessment of long-term sustainability. The study also focused primarily on psychosocial and behavioral variables, excluding biological and economic factors. Finally, qualitative data were collected only from middle-aged participants, limiting insight into the lived experiences of young adults during the intervention phase.

Contributions of the Study

This study contributes to theory, methodology, practice, and policy. Theoretically, it advances an integrated framework combining SCT, LCDT, and HFT to explain PA sustainability. Methodologically, it introduces a time-efficient retrospective synthesis and teaching intervention design. Practically, it provides a structured, evidence-based intervention model and highlights key facilitators of sustained PA. From a policy perspective, the findings support the objectives of the “Healthy China 2030” initiative by offering context-specific strategies for promoting lifelong physical activity.

Recommendations

Based on the findings of this study, several recommendations are proposed to enhance the sustainability of physical activity (PA) across the life course.

For university physical education (PE) policy, it is recommended that Nanchang University adopt a more “transition-ready” curriculum that shifts from a predominantly skill-based approach to one that emphasizes habit formation, adaptability, and long-term wellness. The curriculum should incorporate strategies that prepare students for post-graduation life transitions, including workplace wellness practices and time management for physical activity. Furthermore, the integration of intergenerational mentoring programs is strongly encouraged, wherein university students are paired with middle-aged adults to facilitate knowledge exchange, social support, and the



transmission of adaptive PA strategies. The implementation of “habit flexibility” workshops may also be beneficial, as these can equip students with practical skills to modify their physical activity routines in response to changing life circumstances.

For community health programs, it is recommended that targeted interventions be developed for middle-aged adults, particularly those aged 40–50 years, who are more vulnerable to discontinuing physical activity. Support groups focusing on midlife adaptation strategies may help individuals sustain PA despite increasing life and physical challenges. Additionally, community-based intergenerational physical activity initiatives should be promoted to strengthen social connections and support continuity of engagement between university students and community members.

For future research, longitudinal studies are recommended to track participants over extended periods, such as five years, in order to validate the predictive capacity and long-term effectiveness of the proposed sustainability model. Experimental studies, including randomized controlled trials, may also be conducted to compare the effectiveness of the retrospective synthesis and teaching intervention design with traditional physical education approaches. Moreover, the integration of technological tools, such as wearable fitness devices, is suggested to enhance the accuracy and objectivity of physical activity monitoring across the lifespan.

For public health policy aligned with the “Healthy China 2030” initiative, it is recommended that funding and support be provided for the development of university–community partnerships that promote physical activity through collaborative programs. Policymakers should incorporate life stage-specific strategies into PA promotion frameworks, distinguishing between initiation-focused approaches for young adults and maintenance-oriented approaches for middle-aged populations. Such tailored policies can contribute to the establishment of a comprehensive and sustainable system for lifelong physical activity.

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