

Adherence to a Community Based Tai Chi Program For Low-Income Older Adults

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Abstract

The purpose of the current study was to determine factors affecting adherence in a 16 week Tai Chi program amongst multi-ethnic middle aged and older adults living in a low socio-economic environment in Toronto. Analysis was based on data collected from three Tai Chi cohorts taking place from August 2009 to March 2012. The main outcome variable, adherence, was measured by the total number of sessions attended by each of the participants. Total sample size was 210 participants with a mean age of 68.1 ± 8.6 . Based on the regression model, older age, greater perceived stress, higher education and higher short form-36 mental and physical scores were significantly associated with greater adherence. Conversely, higher baseline weekly physical activity was significantly associated with lower adherence. Our findings suggest we target less educated individuals with poor mental and physical health to optimize adherence for future community based Tai Chi programs.

Dedication

I dedicate this thesis to my grandmother, Aziza Begum Shah. Thank you for your eternal support and encouragement and for playing such a significant and influential role throughout my life.

Acknowledgments

I would like to express the deepest appreciation to my supervisor, Dr. Hala Tamim. Without her guidance, wisdom, and persistent help my thesis and many other of my accomplishments would not have been possible. Although I can be a nuisance at times, you have been understanding and most importantly, patient during our time together. I will forever be grateful for everything you have done for me on a personal and professional level.

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INTRODUCTION

Patterns of physical activity in older adults

Physical inactivity is considered by the World Health Organization (WHO) as the fourth leading cause of worldwide mortality (1). Population studies have shown physical activity to improve health status and reduce the chance of non-communicable diseases of coronary heart disease, diabetes, and stroke, among others (2). However, even with all the positive effects of physical activity, many older adults resort to medication as their primary defence against these diseases. A recent study from England had found the utilisation of prescription drugs has vastly increased from an average of 11.2 prescriptions for every person in the year 2000 to 17.7 prescriptions per person in 2010 (3). This number is even more drastic amongst older adults (65+) in Canada, with 97% of residents living in health care institutions using single medication, compared with 76% in private residents. Additionally, this same study found 12.8% of older adults living in private residents take multiple medications compared to 53% residing in institutions (4). Instead of physical activity, older adults have resorted to prescription medication as the primary choice of dealing with healthcare issues that occur with age, even though it may not be the safest or cost-efficient option.

Although many of these medications have been prescribed to combat diseases such as diabetes and coronary heart disease, various studies have shown that exercise can be safer and as effective as prescription drugs. Pertaining to diabetes, the American Diabetes Association also stated that “effective weight loss, with its pleiotropic benefits, safety profile, and low cost, should be the most cost-effective means of controlling diabetes—if it could be achieved and maintained over the long term” (5). To support this statement, researchers found in a recent meta-analysis that aerobic, resistance, and combined training are all associated with lower HbA1c levels (6).

Interestingly, the decline in HbA1c found through exercise by Umpierre et al. was comparable to the decline in HbA1c by use of the diabetes drug Metformin. Additionally, the antidiabetic drug “rosiglitazone” has been positively correlated with an increased risk of stroke, heart failure, and all-cause mortality and an increased risk of the composite of stroke, heart failure, or all-cause mortality in patients 65 years or older (7). Various studies have demonstrated that physical activity can be used as a method of treating diabetes alongside or instead of prescription medication.

A first of its kind meta-analysis found that exercise may be as good as and potentially better than medication to treat stroke and heart failure. Naci and Ioannidis (8) found that when compared with a control group with no intervention, mortality rates in patients with stroke were better in exercise (Odds Ratio= 0.09, Confidence Intervals=0.01-0.72) when compared to anti-coagulants (OR=1.03, CI=0.93-1.12) and anti-platelets (OR=0.93, CI=0.85-1.01). Additionally, they found patients with heart failure also had a similar odds when comparing exercise (OR=0.79, CI=0.59-1.00) to ACE inhibitors (OR=0.88, CI=0.69-1.16), Beta-blockers (OR=0.71, CI=0.61-0.80), and Angiotension receptor blockers (OR=0.92, CI=0.74-1.09). Moreover, researchers felt that exercise was overlooked in favour of drugs in the treatment of disease and had issues with the lack of studies using exercise to treat disease. Naci and Ioannidis(8) stated that current interventions cater towards clinicians and drugs which “prevents prescribers and their patients from understanding the clinical circumstances where drugs might provide only modest improvement but exercise could yield more profound or sustainable gains”. Overall, growing evidence has suggested that exercise should at minimum be performed along with medication in patients with heart failure (9) and stroke (10) for optimal recovery and prevention of recurring adverse health events.

Although guidelines for participation in physical activity has been set by various government organizations such as the WHO and Center for disease control (CDC), one study found that 68% of older adults in America did not meet these physical activity guidelines set in 2008 (11). This problem does not only exist in the United States. Other “western” countries also do not meet recommended physical activity guidelines for older adults. Research in Canada using the Canadian Community Health Survey found that only 21.3% participated in sufficient amounts of physical activity (12). Similar results were found in Australia where only 25.8% (13) were active and the United Kingdom where 22.57% were active (14). Contrasting these findings, older adults in New Zealand, Brazil, and Switzerland saw greater activity rates in older adults at 51.4% (15), 68.2% (16), and 67.5% (17), respectively. In order to examine factors affecting lack of adherence to physical activity, the socio-ecological model allows for a multi-level approach to examine factors relating to individual circumstances as well as environmental and social context.

The Socio-ecological model

Over the past decade, lack of physical activity and physical health of older adults has become an increasingly discussed issue amongst health care professionals. Lack of physical activity has led to a rise in non-communicable diseases in the adult population (18). Traditional methods of dealing with the onset of health issues after diagnosis have become a financial strain on the health care system with health care promotion being a more financially viable option (19). Recently epidemiologists and health care promoters have studied issues affecting physical activity participation using a multi-level approach. This approach has been labelled the “socio-ecological model” and deals with health behaviour on a multi-dimensional level (20). Multiple levels labelled individual, interpersonal, environmental, policy, and global complete the socio-ecological model. This model takes a broader view of physical activity and allows researchers to

incorporate non-traditional determinants of health. The socio-ecological model builds upon each level and steadily affects more individuals as each stage progresses. A complete understanding of these correlates could increase adults' participation in physical activity and reduce the onset of non-communicable diseases (21). Alternatively, researchers have examined the trans-theoretical model for adoption and maintenance of exercise. However, for this study we shall examine the socio-ecological model as it covers more external factors and is utilized more by researchers. An in depth analysis and explanation of each of the levels in the socio-ecological model will be described in the following sections.

Individual

Individuality is at the core of the socio-ecological model as it is the basis or foundation on which the model builds upon. Individuals have two main components which affect physical activity, namely psychological and biological factors. The individual section of the socio-ecological model is the most important, as physical activity is performed by the individual solely for the individual. Each person is responsible for their own well being and personal health. Although other stages may attempt to influence a individual, the final decision is completed by the individual. However, the individual level of the socio-ecological model can be affected by other levels.

Psychological

Psychological factors are interpersonal skills which consist of cognition, beliefs, and motivation. All three affect physical activity equally albeit on various levels. Cognition is vital to physical activity as Tak et al. found older adults who have lower cognition are less likely to adhere to a physical activity program (22). Additionally, once areas of cognition such as memory, attention,

understand and learning begins to deplete, it becomes even more difficult for older adults to participate in physical activity. Beliefs and motivation are important as understanding the benefits of physical activity and striving for goals may increase participation. Crone and Smith found that adults participate in physical activity to gain a sense of achievement (23) and Finch found older adults exercise due to the health benefits and to offset the effects of aging (24). If all psychological factors promote physical activity in a positive light, older adults may have greater adherence to physical activity.

Biological

Biological factors complete the individual level as genetic factors and evolutionary physiology affect physical activity. Predisposed diseases such as Alzheimer's, cancer, and multiple sclerosis can affect physical activity. Older adults cite health issues and pain as two of the largest barriers to participating in physical activity (25). Even if an individual has the motivation, cognition, and belief to exercise, being predisposed to a disease may limit or hinder an individual's physical ability to exercise. Physical and biological components of the socio-ecological model affect each other, and for an individual to participate in physical activity, both components must be in favour of physical activity participation.

Interpersonal

Interpersonal components of the socio-ecological model consist of cultural norms and practices and social support affect older adults and their abilities to exercise. Cultural norms and practices affect an individual's ability to exercise as it mentally influences their habits. Families may not allow elders to exercise as they believe they may be too fragile or see exercise to be not as important as other tasks. For example, one study found Indian and Pakistani women with

diabetes understood exercise was important but did not deem it practical and cited lack of time as a barrier as other tasks were prioritized (26). Equally important, social support has been shown to influence physical activity in older adults. Studies have shown that older adult women who receive social support from family are more likely to attend physical activity programs after 12 months (27). These interpersonal factors should be taken into account when accounting for the adherence of activity of older adults. Alongside individual factors, interpersonal factors also have impact on the amount of physical activity older adults participate in.

Environmental

Following interpersonal factors, environmental factors affect adherence on a grander scale and can be broken down into three separate levels. First, the social environment which is similar to the interpersonal level but incorporates social relations within the environmental level and has an even greater affect on exercise adherence. Secondly, Built environment is the next aspect of the environmental level which affects exercise adherence in older adults. Built environment is considered an element in our physical environment which has been built by humans (e.g. roads, infrastructure, parks, and buildings). Lastly, Natural environment also plays a part in affecting physical activity, albeit this component may not have as great of an implication as the built or social environment.

Social Environment

The major subcomponent of the social environment is behavioural modelling which can affect and influence an individual's perception about physical activity with mass media campaigns being an example. Finlay and Faulkner found that mass media interventions using social media were successful at changing physical activity behaviours (28). Additionally, implementing

posters that promote the use of stairs instead of elevators have shown to increase physical activity (29). Influence of these promoters may have had an impact on adherence of physical activity in the population as inactive individuals may become more conscious of their activity levels, leading to a potential increase in exercise participation. Additionally, other social implications such as crime and incivilities may have a negative effect on the ability to exercise. Crime can affect adherence to exercise as individuals who live in high crime areas may limit their outings and exercise to remain in the safety of their own homes. For example, Harrison et al.(30) found individuals who live in a low crime area are more likely to go for a leisurely walk as they felt more “safe”, contrary to individuals who live in a high crime areas who felt more “unsafe”. Interestingly, just over 20% would walk more during the day if they felt it was more “safe” and more than two-thirds would go for walks at night if it was “safe”. The social environment plays a large role as behaviour modelling and crime/incivilities are critical aspects which affect exercise adherence.

Built Environment

There are three components which complete the "built environment". First and foremost, the built environment is comprised of the transportation system and includes infrastructure regarding roads and pathways for pedestrians, cars, buses, and bicycles. These impact physical activities as the studies have shown areas with more bicycle paths, pedestrian pathways, greater public transportation access, and those that are more aesthetically pleasing have been associated with higher overall daily physical activity (31,32). Second, the land use and density make up another part of the built environment. Having a mixed land use consisting of industrial, commercial, and residential affects the livelihood and ability to take part in physical activity. Environments which have better access to community centres, recreational facilities, and grocery stores are

considered more liveable and have been shown to increase daily physical activity (33). Lastly, urban design such as sidewalks, street lights, traffic calming measures, and architecture complete built environment. These factors have been shown to be more visually appealing and safer which allows for more participation in daily physical activity (34, 35). As shown in the examples of built environment, allowing for all three components to be optimized within communities can positively affect exercise adherence in older adults.

Natural Environment

This subcomponent is the least controlled out of all the other environmental levels. One example to help change this level would be to increase access to national parks and walking trails which allows more opportunities for outdoor activity, and for exercise to be more appealing for individuals. Research found that adults who walked outdoors found the natural environment to be more appealing and increase mental well-being when compared to indoor environments (36). Additionally, adults who participated in this study were more likely to continue exercising outdoors. Moreover, weather also plays a large part in the ability for individuals to exercise as different seasons affect an individual's willingness to exercise. It has been shown that adults are more likely to participate in physical activity during the summer months compared to the winter months (37). Difference in daily temperature and weather has also been proven to alter physical activity participation as inclement weather (thunderstorms, rain, etc.) is associated with lower daily physical activity (38). Although natural environments cannot be changed, selecting a more favourable natural environment to support physical activity and building infrastructure to support winter activities (e.g. sports complex, indoor tracks) may facilitate overall exercise adherence.

Policy

Regional and national policy follows environment in the socio-ecological model. Various government sectors such as health, education, and recreation create the national and regional policy component. Government health and education initiatives along with government legislation influence physical activity on the largest scale compared to any of the preceding components. Health care promotion initiatives reach out to entire countries to reinforce healthy and active living. An example of a successful health care promotion is the national campaigns against smoking which were introduced in Taiwan to inform the population of the adverse effects of smoking (39). This effectively influenced the population to cease smoking behaviours and allowed the spread of knowledge about the negative effects of smoking. Similarly to the study in Taiwan, today researchers use this same method of health promotion to reach the public by spreading knowledge about the benefits of physical activity. Agita São Paulo is an example of a national health promotion which took place in Brazil in 90's (40). The Agita São Paulo national health care promotion allowed for all citizens of Brazil to benefit from education about physical activity. When citizens of Brazil were asked about the main message regarding Agita São Paulo, over 55% had heard of the campaign and 23% fully understood the message promoting physical activity. Moreover, an example of legislation affecting policy would be the Ontario provincial government, which in 2005 made daily physical activity mandatory in public elementary schools (41). Using these methods of promotion and policy change, reinforcement of positive benefits of physical activity may increase adherence to exercise in all ages, especially older adults.

Global

Lastly, the global level completes the multi-level socio-ecological model. This component consists of global media, marketing, advocacy and economic development. Global advocacy is one of the main contributors towards physical activity promotion in adults. The WHO is the

largest health promotion group in the world and promotes physical activity on a global scale. Using data from various countries, the WHO has created the “Global strategy on diet, physical activity and health” (42). This policy has four main objectives: Reduce risk factors for chronic disease, increase awareness and understanding, monitor science and promote research, and develop and implement global policies and action plans. This global policy allows for knowledge to be spread throughout the world and allows for us to help citizens of the world, as opposed to citizens of a certain country or city allowing healthcare to be promoted on a global scale.

MANUSCRIPT

Predictors of adherence in a community based Tai Chi program

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Introduction

The Canadian physical activity guideline for older adults currently recommends that individuals 65 years or older engage in physical activity for a minimum of 30 minutes a day for at least 5 days a week ¹. Age has been shown to be inversely associated with physical activity with approximately a third of older adults currently meeting physical activity guidelines. Furthermore, ethnic minority groups who reside in low socioeconomic status (SES) environments are even less likely to engage in physical activity ². Without participation in regular physical activity, older adults are more prone to various health-related ailments such as hypertension, stroke, type 2 diabetes mellitus, obesity, breast cancer, and colon cancer ³. On the contrary, older adults who do participate in physical activity programs demonstrate beneficial health outcomes including reduced incidents of falling⁴, increased quality of life and life expectancy ⁵. Psychological health has also been shown to improve; this includes increased happiness ⁶ and decreased irritability ⁷. As the number of older adults increases, participation in physical activity programs can help older adults live healthier, longer lives.

Despite the many benefits of physical activity, approximately two thirds of older adults do not participate in regular activity ⁸, and adherence to such programs is a major challenge, with many participants failing to regularly attend in the first few months and ceasing to attend thereafter ⁹. Studies have shown that short term dropout rates are almost 2.5 times greater than long term dropout rates (29% vs. 73%) amongst community-based physical activity programs for older adults ¹⁰. A number of studies to date have evaluated older adults' adherence to community-based physical activity programs such as walking groups and strength training classes. ¹¹⁻¹³. Results from these studies suggest that socio-demographic characteristics such as having a higher education ¹¹ are associated with higher adherence to physical activity programs.

Equally important, health characteristics such as high self-efficacy¹² and higher self-perceived physical health¹³ scores have been shown to be positively correlated. Conversely, low social support from peers/group leaders to participate in physical activity¹⁴ is a social characteristic associated with low adherence. Unfortunately, research is very limited in assessing the association between physical functioning and adherence. However, of the few studies conducted, it has been shown that adherence to physical activity programs in older adults is positively associated with better cognitive capacity such as higher reaction time¹³ and greater physical functioning such as faster walking speed¹⁵.

Tai Chi is a form of physical activity which utilizes low impact movements and low intensity aerobic activity¹⁶. The swift and slow movements result in a physical activity with very little risk of injury. Furthermore, many studies have demonstrated that Tai Chi involving older adults is a safe and beneficial form of physical activity which can decrease joint pain¹⁶, reduce falls⁴, and increase quality of life¹⁷. Other components of fitness have also been shown to improve, most notably strength¹⁸, and flexibility¹⁹. Tai Chi has also been shown to decrease depression²⁰ and anxiety²⁰, whilst increasing self-efficacy²¹ and self-esteem²². Even more appealing is the low cost of maintaining a Tai Chi program, as it does not require any extra equipment or costly facilities²³. It requires only a limited amount of space to perform movements, and may be practiced in any open area such as parks and community centres. Dropout rates for Tai Chi programs for older adults have been reported to be <25%²⁴, and while researchers have acknowledged that attendance rates drop after Tai Chi initiation²⁵, characteristics and predictors pertaining to attendance have not been a focus. Lastly, researchers have yet to focus on a multi-ethnic participant pool, as there is a lack of literature observing

adherence to community based physical activity programs in older adults with a diverse ethnic sample.

Given the current growing population of older adults and the increasing popularity, effectiveness, and affordability of Tai Chi, understanding factors and predictors of adherence will provide important insight into the utility of Tai Chi programming in an increasingly diverse, older adult population in Canada. Because little is known about adherence to Tai Chi programs, the purpose of the current study is to determine demographic, behavioral, physical and mental health factors affecting adherence in a 16 week Tai Chi program amongst multi-ethnic middle aged and older adults living in a low SES environment within a major Canadian city.

Methodology

Study Design

The present study was part of a larger study²⁶ with the objective to assess the effectiveness of Tai Chi improving physical and mental health of older adults.. For this study three cohorts were conducted at two locations in the Greater Toronto Area; Jane and Finch as well as Dundas and Spadina. These areas were chosen for their diverse ethnic make-up and their low SES²⁷. The Jane and Finch community consists of over 50,000 people and visible minorities make up over 70% of its population²⁸. Dundas and Spadina contains a high concentration of older adults of Chinese origin²⁹. The first cohort took place in a Jane and Finch Toronto Community Housing building and participants were followed from August 2009 to December 2009. The second cohort took place in a community center located at Dundas and Spadina and participants were followed from March 2011 to July 2011. Lastly, the third cohort took place in a Jane and Finch community centre from November 2011 to March 2012.

Participants

Participation was restricted to individuals who were 50 years of age and older, who lived in either community with the medical capacity to participate in an exercise program. Participants were screened by the Physical Activity Readiness Medical Examination (PAR-Med-X)³⁰ and the Physical Activity Readiness Questionnaire (PAR-Q)³¹.

Tai Chi Program

The Tai Chi program for each of the cohorts ran for 16 weeks with 6-7 classes offered per week, and participants were encouraged to attend at least 2 classes per week. Three separate qualified Tai Chi masters each conducted and supervised their respective cohorts. Instructors were all male, trained in Yang style and ranged from age 65-84. All classes consisted of a 15 minute warm up of Qigong followed by 45 minutes of Yang style Tai Chi for a total of 60 minutes per class. Yang style Tai Chi emphasises body and trunk rotations while utilizing body alignment awareness. Tai Chi classes were offered free of charge to all participants. Participants were recruited for this study using flyers, newspaper advertisements, and word of mouth. No participants were paid for attending any Tai Chi sessions, however, participants from the second and third cohorts received a ten dollar gift card upon completion of post-cohort questionnaires.

Adherence Measures

A research assistant monitored and collected attendance for each class. For the present study, the outcome variable, adherence, was measured by the total number of sessions attended by each of the participants.

Independent variables

The predictor variables considered were demographic, behavioural and health, physical, and psycho-social. The demographic variables included age, gender, marital status, education, and income³². Behavioural and health variables included smoking, alcohol use, weekly physical activity using the Canadian physical activity fitness & lifestyle approach (CPAFLA) health benefit zone³³, co-morbidities, and the physical and mental components of the Short Form-36 (SF-36)³⁴. Physical variables evaluated were hand grip strength, timed "up and go" test, and sit and reach. Psycho-social measures consisted of the modified social support scale by Huang et al³⁵ and perceived stress scale³⁶. A brief description of all predictor variables can be found in the primary paper by Manson et al²⁶.

Statistical Analysis

The outcome, total sessions attended, was compared across the different categories of the demographic, behavioural and health, physical, and psycho-social characteristics of study participants. To assess the bivariate relationship between the predictor variables and adherence, t-test and analysis of variance (ANOVA) were performed for categorical variables and simple linear regression was performed for continuous variables. Additionally, multiple linear regression analysis was performed to assess the independent relationship between participants' characteristics and number of session attended. For the multiple linear regression model (enter method) the outcome variable was number of Tai Chi sessions attended. Predictor variables were the 3 cohorts and predictor variables of Demographic (gender, education, marital status) Behavioural and Health (co-morbidities, weekly physical activity, SF-36 mental, SF-36 physical) Physical (combined hand grip, up and go, sit and reach) and Psycho-social (social support, perceived stress scale). All analyses were conducted using SPSS 21 with statistical significance set at $\alpha < 0.05$. The study protocol was approved by the ethics review committee of York

University and all data was obtained using informed and written consent from all study participants. Individuals who were illiterate or unable to understand the questionnaire had verbal confirmation obtained followed by written consent.

RESULTS

Of the 210 participants who were enrolled in the Tai Chi intervention, cohort 2 accounts for the greatest number of participants with 80 (38.1%), followed by cohort 1 with 78 (37.1%).

Characteristics of the sample are shown in Table 1. Overall, 167 (79.9%) participants were female, only 29 (15%) had more than high school education, and 135 (71.4%) earned less than \$14,000 per year. The average age of participants was 68.1 ± 8.6 years (range=50-87 years). Chinese and South American individuals comprised of a majority of participants with 74 (36.1%) and 54 (26.3%) participants, respectively. Regarding chronic conditions, 123 (58.5%) had two or more conditions with hypertension and arthritis having the highest number of participants diagnosed with 105 (50.0%) and 102 (48.6%), respectively.

The average number of sessions attended for the combined cohorts was 16.8 ± 15.1 . A significant difference ($p=.036$) in the average sessions attended was observed among the three cohorts with cohort 3 averaging the most sessions attended (mean = 21.4 ± 13.7), followed by cohort 2 (mean = 15.9 ± 18.3) and cohort 1 (mean= 14.7 ± 11.4). Fisher's least significance (LSD) post-hoc test found a significant difference between cohorts 1 and 3 ($p=.013$) and cohorts 2 and 3 ($p=.040$). The number of participants who attended the different sessions ranged from a minimum of 5 participants per session to a maximum of 34 participants per session (range for cohort 1 of 5-20, range for cohort 2 of 6-34) and range for cohort 3 of 4-24). Additionally, of the 210 participants who enrolled, 56 (26.7%) were lost to follow up. None of the demographic, behavioural and health, physical and psycho-social variables were statistically significant

between those who completed the study and those who were lost to follow up (results not shown). Furthermore, Table 1 displays the mean differences between total sessions attended and baseline demographic, behavioural and health, physical health, and psycho-social characteristics of study participants. No significant mean differences were found among demographic or psycho-social variables using bi-variate analysis. Simple linear regression found sit and reach as the only significant predictor of adherence ($\beta = 0.33, p = .006$). Additionally, simple linear regression found SF-36 physical component total ($\beta = 0.32, p = .024$) to be significant while SF-36 mental component total ($\beta = 0.22, p = .075$) approached significance.

Results of the multiple linear regression analysis using standard enter method are shown in Table 2. Demographic variables age ($p = .049$) and education ($p = .027$) were found to be significant predictors of adherence ($R^2 = .191$). Participants with greater than high school education attended on average 9 more classes than those who had less than high school education ($\beta = 9.30, p = .027$). Additionally, older age was a significant predictor of more sessions attended ($\beta = 0.39, p = .049$). Although no physical components reached statistical significance, there was a trend for sit and reach ($\beta = .027, p = .072$). Participants who indicated better physical ($\beta = 0.52, p = .025$) and mental health ($\beta = 0.45, p = .039$) were likely to attend more total sessions. Conversely, weekly physical activity ($\beta = -1.20, p = .009$) was negatively associated with more sessions attended. Amongst psycho-social variables, participants who were more stressed were more likely to attend classes ($\beta = 0.37, p = .059$).

Discussion

This study is the first to examine predictors of adherence to a Tai Chi program in Canadian, low income, multi-ethnic middle aged and older adults over a 16 week intervention. Overall, 94 (46.5%) of our sample did not attain high school education and 135 (71.4%) earned less than

\$14,000 annually. It has been shown that older adults residing in low SES environments within Canada are more prone towards morbidity and lack of exercise³⁷. Our findings are of importance as predictors of adherence to physical activity programs can benefit vulnerable low SES communities. Based on the multiple linear regression analysis, our findings suggest that adherence is positively associated with older age. Moreover, participants who scored greater on the SF-36 mental and physical questionnaire were more likely to attend the Tai Chi classes being offered. Participants who completed greater than high school education were more likely to attend classes compared to participants who did not complete high school. Greater scores on the sit and reach test and the perceived stress questionnaire were also associated with more sessions attended. Conversely, our findings suggest that participants who were more physically active at baseline attended on average lower number of Tai Chi classes compared to those who were less physically active.

Results of the present study showed that increasing age was positively associated with more sessions attended. This finding is consistent with the work of Hopman-Rock et al.³⁸ who studied the effects of a 7-month television-based exercise program tailored towards older adults. In that study, increasing age was found to be a significant predictor of adherence to this exercise program. Additionally, Tobi et al³⁹ found a positive relationship between increasing age and adherence to government-funded exercise programs (e.g., swimming, circuit training, or walking clubs) in a sample consisting mainly of members of ethnic minorities. In our study, this finding may be explained by multiple factors such as greater leisure time available among middle aged and older adults, social networks developed throughout the sessions among study participants and Tai Chi master, Tai Chi's gentle nature, and the flexibility to schedule around daytime classes. Additionally, our results are consistent with other studies that show higher education

was correlated with greater adherence to physical activity programs^{40 41}. For example, Stineman et al. found that older adults who achieved greater than a high school education were more likely to attend an onsite exercise program⁴⁰. Future physical activity programs in low SES environments should consider utilizing additional resources targeting lower educated individuals such as educational sessions or phone call reminders to increase adherence.

From among the behavioural and health variables studied, weekly physical activity, SF-36 physical component, and SF-36 mental component were all found to be significant. Participants who reported greater weekly physical activity rates at baseline were significantly *less* likely to adhere to the Tai Chi program. These findings contradict previous research which found that individuals who participate in more physical activity are more likely to attend aerobic physical activity programs^{41 42}. We speculate that our results are due to the leisurely pace and low calorie expenditure that Tai Chi offers which has been compared to low-moderate walking speeds⁴³. Moreover, Tai Chi instructors catered classes towards individuals who were unfamiliar with Tai Chi. Although Tai Chi's leisurely pace may have encouraged inactive adults to participate, the lack of physical exertion may have deterred more active middle aged and older adults from adhering. Additionally, both physical and mental SF-36 scores were positively and significantly associated with greater Tai Chi adherence. Interestingly, no studies to our knowledge have used the complete SF-36 questionnaire as a predictor of adherence to physical activity programs in older adults. However, Tiedemann et al.¹³ found individuals, who scored greater on the shorter SF-12 physical component took more steps in their exercise program. Administering the SF-36 questionnaire at baseline is a practical method of predicting adherence to physical activity programs in multi-ethnic, low SES, middle aged and older adults.

The present study showed no significant relationship between adherence to our Tai Chi program and the predictors of hand grip strength and up and go walking speed. Similar results in terms of adherence and hand grip strength were reported in studies by Jette et al.⁴⁴ and adherence and walking speed by Tiedemann et al.¹³. Furthermore, as shown by the sit and reach test, a positive relationship exists between flexibility and adherence, albeit this association only approached significance. One possible explanation for our findings may be that Tai Chi is a gentle, low intensity exercise which allows participants to partake at their own leisurely pace. Slow movement and tempo associated with Tai Chi does not require participants to be agile and strong to adhere, but allows middle aged and older adults who may be in poor physical condition (and a lower general fitness level) to engage in less strenuous (and tailored) bouts of activity. Additionally, mastery of Tai Chi poses which required flexibility may have boosted self-confidence amongst participants resulting in greater flexibility. However, elongated poses and stretching associated with Tai Chi may have negatively affected individuals with poor flexibility, thus limiting their adherence to our program. Nonetheless, the interesting finding of the positive relationship between baseline flexibility and adherence warrants further research.

Although some research has suggested that psycho-social factors such as stress may limit older adults' participation in physical activity, none have explicitly assessed the practice of Tai Chi. For example, Laugero et al.⁴⁵ found a significant relationship between greater stress scores and lower physical activity in older adults, however these results are contrary to the trend we observed within our study results. We suggest that the social interactions developed among peers in a community-based setting and the relaxed pace of Tai Chi contributed to the relationship. Moreover, lower anxiety and stress from actively participating may have allowed for an increase in capability and self-confidence resulting in better adherence.

There are several limitations that should be taken into consideration regarding the validity of the results. First, as opposed to a randomized control trial, daily changes could not be accounted for in physical activity, lifestyle, attitude, and behaviour. Secondly, each cohort took place in a different season, therefore disparities attributed to seasonal variations may have impacted adherence. Equally important is that, excluding fitness measures, all other data was collected through self-report questionnaires with participants choosing to partake in the study themselves, hence limiting generalizability and creating the possibility of self-report bias. Additionally, our sample size only contained 210 participants, therefore widely dispersed categories such as ethnicity could not be entered into the multivariate regression. Lastly, all cohorts were administered by different instructors, possibly allowing their personal style to affect progress and attendance which has been demonstrated in a previous study⁴⁶.

In conclusion, our results provide added insight into predictors of adherence to a community based Tai Chi program for low SES, multi-ethnic middle aged and older adults, residing in a major Canadian city. On this basis, programs tailored to less educated individuals with poor mental and physical health may be necessary to optimize adherence within the most at-risk segment of the older adult population. Future research should focus on flexibility measures and perceived stress as potential predictors of adherence to a community based Tai Chi program.

Table 1. Baseline characteristics of study participants and mean differences with Tai Chi sessions attended

	N (%)	Sessions attended Mean (SD)	<i>p</i>
Cohort	210 (100)	16.8 (15.1)	
1	78 (37.1)	14.7 (11.4)	
2	80 (38.1)	15.9 (18.3)	
3	52 (24.8)	21.4 (13.7)	.036
Demographic			
<i>Gender</i>			
Male	42 (20.1)	14.0 (13.6)	
Female	167 (79.9)	17.6 (15.4)	.168
<i>Age groups</i>			
50-64 years	73 (35.3)	16.2 (14.7)	
65-74 years	86 (41.5)	16.9 (14.7)	
75+ years	48 (23.2)	18.4 (15.0)	.735
<i>Education</i>			
< High School	94 (46.5)	15.0 (14.1)	
High School	79 (39.1)	16.8 (15.4)	
> High School	29 (14.4)	21.1 (14.4)	.152
<i>Marital Status</i>			
Unmarried/Widowed/Divorced	112 (54.9)	16.6 (13.6)	
Married with Partner	92 (45.1)	16.9 (16.3)	.904
<i>Annual Income^a</i>			
<\$14,000	135 (71.4)	16.5 (15.7)	
\$14,000-\$30,000	35 (18.5)	18.4 (13.7)	
>\$30,000	19 (10.1)	14.4 (11.1)	.661
<i>Ethnicity</i>			
Chinese	74 (36.1)	17.0 (19.2)	
South American	54 (26.3)	14.2 (12.4)	
European	33 (16.1)	19.5 (12.0)	
Other	31 (15.1)	17.8 (11.1)	
Canadian	13 (6.3)	21.5 (14.5)	.414
Behavioural and Health			
Smoking	4 (1.9)	5.2 (8.6)	.122
Drinking	45 (21.4)	17.7 (13.7)	.649
<i>Chronic Conditions</i>			
Hypertension	105 (50.0)	16.4 (13.8)	.692
Arthritis	102 (48.6)	17.5 (14.5)	.483
Diabetes Mellitus	45 (21.4)	14.1 (12.5)	.175
Sleep Disturbance	54 (25.7)	15.2 (13.7)	.378
Depression	31 (14.8)	18.4 (13.1)	.531
Hearing Impairment	26 (12.4)	17.2 (17.3)	.878

Heart Disease	12 (5.7)	12.5 (9.7)	.299
COPD ^b	10 (4.8)	10.6 (9.2)	.181
Two or More Conditions	123 (58.5)	16.1 (13.0)	.456
	Mean (SD)	β (SE)	
<i>Physical Activity</i>			
Weekly Physical Activity ^c	6.72 (3.0)	-0.53 (.34)	.121
<i>SF-36^d</i>			
<i>Total</i>			
Physical component	49.2 (7.8)	0.32 (.14)	.024
Mental component	52.0 (8.9)	0.22 (.12)	.075
<i>Physical Health Sub-scales</i>			
Physical functioning	75.0 (21.6)	0.06 (.04)	.175
Role Physical	79.7 (27.2)	0.12 (.03)	.001
Bodily pain	68.7 (24.7)	0.07 (.04)	.072
General Health	64.8 (20.4)	0.10 (.05)	.052
<i>Mental Health Sub-scales</i>			
Vitality	64.2 (20.1)	0.04 (.05)	.360
Social Functioning	86.5 (20.0)	0.07 (.05)	.168
Role Emotional	83.5 (24.3)	0.13 (.04)	.002
Mental Health	75.0 (17.3)	0.08 (.06)	.149
Physical			
Combined hand grip (kg)	54.2 (17.6)	0.03 (.06)	.604
Up and Go (seconds)	7.6 (3.2)	-0.02 (.33)	.932
Sit and Reach (cm)	26.4 (9.0)	0.33 (.12)	.006
Psycho-social			
Social support	4.5 (1.9)	-0.05 (.52)	.915
Perceived stress scale	18.9 (8.5)	-0.12 (.12)	.335

^aIncome currency is Canadian dollars

^bCOPD = Chronic obstructive pulmonary disease

^cPhysical Activity: based on the Healthy Physical Activity Participation Questionnaire

^dSF-36 = Short form-36 health survey

Table 2. Results of multiple linear regression analysis for the mean differences between participants' characteristics and Tai Chi sessions attended

(N=210)	β^a (SE)	β^b	<i>p</i>	95% CI
Cohort				
1	0.28 (3.3)	.009	.932	-6.3 - 6.9
2	Referent	---	---	---
3	1.50 (3.7)	.040	.684	-5.8 - 8.9
Demographic				
<i>Gender</i>				
Female	5.90 (4.7)	.152	.211	-3.3 - 15.2
Male	Referent	---	---	---
Age	0.39 (.19)	.217	.049	.001 - .787
<i>Education</i>				
< High School	Referent	---	---	---
High School	3.30 (2.7)	.106	.219	-2.0 - 8.7
> High School	9.30 (4.1)	.210	.027	1.0 - 17.6
<i>Marital status</i>				
Married with partner	2.90 (3.2)	.096	.362	-3.4 - 9.3
Unmarried/Widowed/Divorced	Referent	---	---	---
Behavioural and Health				
<i>Co-morbidities</i>				
Less than two	Referent	---	---	---
Two or more	0.32 (2.8)	.096	.910	-5.2 - 5.9
<i>Physical Activity</i>				
Weekly physical activity	-1.20 (.45)	-.235	.009	-2.1 - -.311
<i>SF-36</i>				
SF-36: Physical component	0.52 (.22)	.241	.025	.068 - .974
SF-36: Mental component	0.45 (.22)	.225	.039	.023 - .896
Physical				
Combined hand grip	0.06 (.11)	.071	.587	-.158 - .278
Up and go	0.99 (.68)	.158	.149	-.363 - 2.3
Sit and reach	0.27 (.15)	.164	.072	-.025 - .568
Psycho-social				
Social support	0.39 (.92)	.042	.670	-1.4 - 2.2
Perceived stress scale	0.37 (.19)	.206	.059	-.015 - .773
R²		.191		

^aUnstandardized Beta

^bStandardized Beta

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EXTENDED DISCUSSION

What we found

Our study examined predictors of adherence to a 16 week community based Tai Chi program for older adults residing in a low income community. Our study is the first to look at adherence specifically to a Tai Chi program, however previous literature surrounding older adults' adherence to community based programs has found similar results (43-46). Greater adherence to our Tai Chi program was positively associated with higher education and older age. Mental and physical components of the SF-36 questionnaire were also found to be positively and significantly associated with adherence. In contrast to other literature (47), we also found that lower adherence to our program was associated with less stress and less baseline weekly physical activity.

How to take action

Studies have shown that older adults who are physically inactive have elevated risk of mortality (48). Moreover, low income older adults are at even greater risk due to health differences between socioeconomic environments (49). Toronto public health has projected a reduction of citizens belonging to the middle class resulting in an increase of the low income population (50). Community-based Tai Chi programs can boost health in the growing lower income population, however it is pivotal that participants continuously attend these programs to decrease potential health risks. Identifying older adults who are less likely to adhere to physical activity programs is essential for success. In order to improve adherence to future physical activity programs targeting older adults, we suggest the following interventions:

- i) First, we suggest using a "partnership" to match up low and high adherers. Having a "buddy system" could potentially allow low adherers to be motivated by high adherers. A similar method was used by Estabrooks and Carron (51), who found that older adults participating in strength and aerobic class using team building activities had greater adherence rates compared to a similar class not using team building activities. Advertising Tai Chi as a group or paired exercise as an alternative to individual exercise may increase adherence.
- ii) Second, financial incentives to upkeep adherence during future Tai Chi programs may be beneficial to increase overall adherence. Specifically, our low-income demographic may have yielded a greater adherence rate if a financial incentive was offered. Similarly, a study by Herman et al. (52) found that adults who were offered \$150 to join an online exercise program reduced their physical inactivity by 8.4% using an interactive "activity logging database". Another study by Jeffery et al (53) found financial incentives to increase adherence to walking in obese adults, however by the end of the study no additional weight had been lost. Using monetary incentives should be looked into with greater detail as incentives may initially increase the adherence rate, but if participants lack motivation and self-efficacy there may be little long-term personal benefit.
- iii) Third, allowing for exercise co-ordinators to actively call participants or send SMS messages reminding them to attend could be beneficial. Phone calls are a valuable, non-invasive, and cost-efficient method of reminding participants to attend once adherence begins to decline. Periodic phone calls act as a reminder and also provide encouragement to participants (54, 55). Additionally, these phone calls may be used

- as an opportunity to discuss any troubles or impediments the participant may have while attempting to adhere to Tai Chi.
- iv) Fourth, setting self-regulated goals using self-monitoring in order to improve adherence on a personal level. These skills can be facilitated by instructing individuals that exercise is a behavioural goal with a purposeful end. Exercise maintenance and adherence should be seen as a challenge with an end goal in sight to avoid frustration and anger. For example, set a SMART (specific, measurable, attainable, realistic, time-oriented) (56) goal to be achieved by the end of seasonal classes. For example, in Tai Chi we can have participants learn to master 20 specific techniques by the end of the summer, once those 20 have been mastered, 10 more techniques may be added to be completed by the end of fall.
 - v) Lastly, incorporating a food or meal program into a Tai Chi program may increase overall adherence. Low SES older adults struggle financially and our sample displayed that a majority earn less than \$14,000 annually. Food incentives may reduce costs for the participants (no purchased lunch for the day/free meal). By providing a free healthy lunch, a Tai Chi program may seem more appealing as participants can continue to attend classes. Future research studying community based Tai Chi programs should consider using food incentives while tracking adherence.

Future studies

Greater participation in community based Tai Chi programs are pivotal to ensuring long-term sustainability and funding. Without a high attendance rate, many programs may cease to exist as the cost-benefit ratio will diminish. Alongside the financial implications, our Tai Chi program

found positive results amongst participants with low adherence which could be increased with greater adherence. Our study targeted only the individual and interpersonal levels of the socio-ecological model. Specifically, our study looked at the psychological and biological factors. Additionally, social support and marital status were also briefly examined. Using the socio-ecological model we suggest that future studies look at the following recommendations.

Incorporating intrapersonal measures such as cognition and beliefs would assist in developing the individual level of the socio-ecological model. Although we examined social support on the interpersonal level of the socio-ecological model, our study created an overall score and did not utilize individual components. Future studies should determine whether individual social support systems from family, friends, neighbours, and work have an effect on adherence. Additionally, various cultural norms and practices were unable to be assessed. Practices such as smoking, drinking, religion, political values, and country of origin should be considered for use in future studies tackling the socio-ecological model.

Unfortunately, we were unable to touch any part of the environmental, policy, and global levels of the socio-ecological model. Global factors have the largest overall effect and directly affects national and regional policies. In order to fully understand the potential implications of global factors affecting adherence to Tai Chi programs, we feel identical studies on exercise adherence to Tai Chi should be replicated in various countries across the globe. Various factors such as cultural norms, state laws, and traditions may have an effect on exercise adherence. Once these differences are obtained we would be able to determine if global factors such as culture and state/nation directly affect adherence. Once this has been determined we can individually make suggestions for national and regional policies as they may differ dramatically. To develop these policies we should research the effectiveness of current strategies promoting physical activity.

Are our current campaigns to promote physical activity and fitness working? Is the message being spread to the masses? Are the masses receiving these messages? We suggest questionnaires to determine if older adults are understanding the basic benefits of physical activity, where they are getting their information from, and if they are actively working on becoming more active. Mass media campaigns have shown to be an effective method of reaching large numbers of people (57), however the understanding of these messages has yet to be determined. After this information has been collected, researchers can determine if a correlation exists between adherence in older adults and the understanding of national/regional policies.

Built and natural environments should be discussed and incorporated prior to study initiation. If adherence is the main outcome for the study, locations for Tai Chi classes should be as heterogeneous as possible. Researcher should attempt to have locations accessible by transit in large urban communities and also have classes take place in suburban/rural communities to determine if distance and geography affects adherence. Additionally, have classes take place in similar cities with different geographical climates. For example, having one study in Vancouver would allow researchers to determine if the natural environment consisting of the Pacific Ocean, national parks, and mountainous regions affect the adherence rate. This would be comparable to a city such as Toronto which lacks these physical attributes and only has Lake Ontario and various smaller towns surrounding its large urban area.

Lastly, to determine if the social environment plays a factor, Tai Chi classes should have a certain level of social interaction. Alongside a control group, researchers could determine the difference between classes with the experimental group utilizing social interactions such as group exercises and "buddy systems". Moreover, team cohesion exercises could be implemented

into classes to build a rapport between participants. Using this data, researchers can determine if social habits directly affect adherence to exercise programs.

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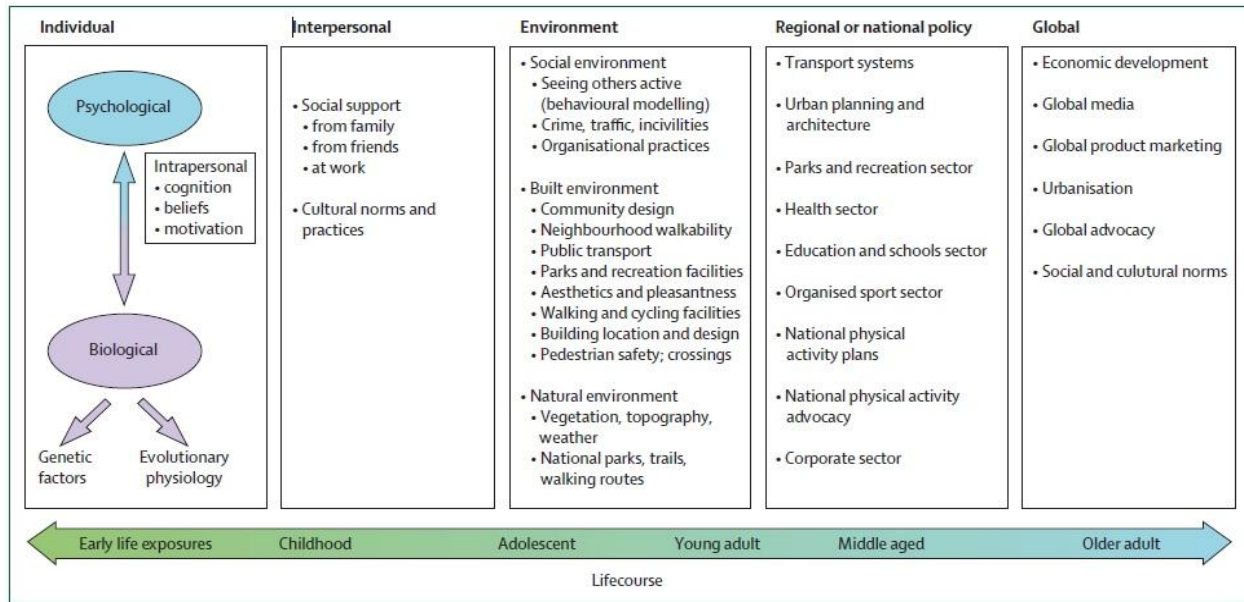
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Appendices

Figure 1. The Socio-ecological Model



Bauman, A. E., Reis, R. S., Sallis, J. F., Wells, J. C., Loos, R. J., & Martin, B. W. (2012). Correlates of physical activity: why are some people physically active and others not?. *The Lancet*.