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The Arts for Ageing Well: A Propensity Score Matching Analysis of the Effects of Arts Engagements on Holistic Wellbeing among Asian Elderly Population

Andy Hau Yan Ho[1, 2*], Stephanie Hilary Xinyi Ma[1], Moon-Ho Ringo Ho[1], Joyce Shumin Pang[1], Emily Ortega[3], Ram Chandra Bajpai[2]

[1]Psychology Programme, School of Social Sciences, Nanyang Technological University, Singapore.

[2]Centre for Population Health Sciences, Lee Kong Chian School of Medicine, Nanyang Technological University, Singapore.

[3]Psychology Programme, School of Humanities and Behavioral Sciences, Singapore University of Social Sciences, Singapore.

* Correspondence to: Dr Andy Hau Yan Ho, School of Social Sciences, 48 Nanyang Avenue, HSS-04-03, Singapore 639818. Email: andyhyho@ntu.edu.sg   Tel: +65 6316 8943

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Abstract

Objective: To assess the frequency and intensity of arts engagement inclusive of active and passive engagements in arts, culture and heritage activities among Singaporean adults aged 50 and above, and to examine the relationships between participatory art and holistic wellbeing.

Setting: All residential areas across Singapore's Central, East, North, North-East and West Regions.

Participants: 1,067 community-dwelling, older adults between the ages of 50-95 years were recruited in Singapore via a stratified random household survey.

Primary and secondary outcome measures: Respondents completed a self-reported questionnaire, consisting of standardized ad hoc items assessing the frequencies and durations of active and passive participatory arts engagement, as well as validated psychometric assessments on psycho-socio-spiritual health including the primary outcome measure on quality of life, and the secondary outcome measures on physical, psychological, emotional, spiritual, and social well-being. Socio-demographic information, as well as frequency and intensity of physical activity were also collected.

Results: Passive engagement (60%) and active engagement (17%) in the arts were associated with better holistic wellness and social support. Specifically, findings from the PSM and independent t-test analyses revealed that elders who attended arts and culture-related events experienced higher quality of life [$t(728)$=-3.35, p=0.0008, d=0.25], perceived health [$t(728)$=-2.21, p=0.0227, d=0.16], and sense of belonging [$t(728)$=-2.17, p=0.03, d=0.16], as compared to non-art attendees. Moreover, seniors who engaged in participatory arts experienced greater quality of life [$t(442)$=-3.68, p=0.0003, d=0.36], self-rated health [$t(442)$=-2.59, p=0.0099, d=0.25], spiritual wellbeing [$t(442)$=-3.75, p=0.0002, d=0.37], meaning in life [$t(442)$=-5.02, p<0.0001, d=0.50], and sense of peace [$t(442)$=-3.72, p=0.0002, d=0.36], as compared to non-art participants.

Conclusion: This study provided robust evidence to support a significant causal relationship between arts engagements and holistic wellbeing. Recommendations for art-based public health and elderly care research, practice and policy are discussed.

Keywords: *Holistic wellbeing; Creative ageing; Participatory art; Propensity score matching; Public Health, Mental Health; Asia*

STRENGTHS AND LIMITATIONS OF THIS STUDY

- First-ever empirical research to date that examined arts engagements and its impact on holistic wellbeing in Asia using naturalistic observational data.

- Sample was a large, representative older adult population in Singapore

- Propensity score matching (PSM) analysis was employed to minimize selection bias and avoid problems of endogeneity, allowing for comparisons between groups art-active and non-art-active groups.

- A wide range of art forms were assessed, of which included active engagements and passive consumption of eight art forms - music, dance, theatre, literary arts, visual arts, heritage activities, and craft events.

- Self-reported questionnaire with psychometric measures may elicit subjective responses and recall biases in this study.

INTRODUCTION

Asia is ageing at a much faster rate than anywhere else in the world.[1] In Singapore specifically, the proportion of adults aged 65 and above has more than doubled in the past two decades from 6% in 1990 to 13% in 2017. This trend will exponentially increase to approximately 25% by 2030.[2] Longevity, however, does not necessarily reflect better health at old age. According to recent statistics, 9 in 10 older Singaporeans suffered from a chronic health condition, with 43% diagnosed with at least three comorbid chronic diseases, and 19% agonized by depression and dementia.[3, 4] In addition, 51% of Singaporean older adults reported feelings of loneliness and were at a greater risk of mortality.[5] These numbers reflect greater demands for health and social care services among the aged in the foreseeable future.

While traditional biomedical models have focused predominantly on supporting elderly health through curative interventions and rehabilitation services, contemporary public health approaches emphasize a health-promoting paradigm for maintaining and elevating the holistic wellbeing of older adults, through cultivating personal autonomy, social participation and community involvement.[6] One has to look no further than to the Arts to realize its vital significance in cultivating these goals, as engagements in the cultural heritage of music, dance, theatre, literature as well as the visual arts have been known to have tangible effects on health and quality of life, whereby the agents of creativity and imagination can help "keep individual resilience, aid recovery and foster a flourishing society" (p.3).[7] Despite the extensive use of the arts for its therapeutic properties across history, research investigating healthy and active ageing through arts engagement are recent.[8]

To consolidate existing research that investigated the relationship between arts engagement, health wellbeing and ageing, a literature search was conducted through PsycInfo, Web of Science, Social Science Citation Index, PubMed, and Medline. Relevant reports and studies published by governments and related organizations were also examined. Among community dwelling older adults, multiple reviews of empirical research that studied the relationships between art-based interventions and healthy ageing revealed that active engagements in various forms of art produced positive cognitive, affective, and quality of life outcomes.[9-11] The efficacy of the arts in the treatment of mental health conditions, as well as support for the treatment of various chronic health conditions were also reviewed and documented.[12,13] Finally, a few systematic reviews also suggested that participatory art activities were beneficial for dementia patients living in residential care settings, serving to enhance cognitive processes, attention, mood and memory.[14, 15] Finally, although limited,

art and cultural heritage-based intervention studies with Asian populations have also shown similar positive results in psychological wellbeing.[16]

Despite robust evidence on the benefits of art-based interventions applied in the abovementioned settings, much less research has examined the impact of arts engagements in naturalistic settings.[17] In fact, many studies employed simple pre-and-post intervention designs without control groups, while others employed relatively small sample sizes that prevented meaningful comparisons.[11] Often, participants of these studies were recruited via convenience sampling rather than random sampling, potentially resulting in response biases.[12] Taken together, generalizability may not be ascertained. With a rapidly ageing population in Asia, there is an imminent need to investigate the relationships between arts engagement and holistic well-being among Asian elderly. To date, this relationship has not been empirically examined. The "Arts for Ageing Well" study was the first-ever attempt to critically address this important knowledge gap by utilizing a holistic investigative approach with both quantitative and qualitative methodologies for exploring and understanding the notion of ageing well with the arts. The goal of this study was to generate new knowledge by contributing to the growing literature, as well as advancement of practices and policies for promoting sustainable art participation among the current and future older generations of Singapore and greater Asia. The article reports the quantitative findings of the Arts for Ageing Well study.

Research Objectives

The specific objectives of this study were to (i) assess the frequency and intensity of arts engagement inclusive of active and passive engagements in music, dance, theatre, literary arts, visual arts, heritage events and activities, art exhibitions, and craft events among Singaporean adults aged 50 and above, and to (ii) examine the relationships between participatory art and holistic well-being in terms quality of life, physical, psychological, emotional, spiritual, and social well-being.

METHODS

Study Design and Participants

1,067 participants were recruited between July 2016 and February 2018 across all regions of Singapore via a cross-sectional stratified random household survey to ensure sample representativeness of the national population. Sample size calculation was based on power analysis; a sample size of 1,067 allows for ± 3% accuracy at the 95% confidence level. A sampling frame comprising all residential dwelling units with at least one resident aged 50 and above, and spanning across all geographical areas demarcated by the Urban Redevelopment Authority as residential areas that cover Singapore's Central, East, North, North-East and West Regions, was obtained from the Singapore Department of Statistics. Dwelling units were grouped into four non-overlapping strata according to age group, and were further stratified into gender, ethnicity, and housing types. Based on the resulting Master List, a fixed number of dwelling units were selected by a systematic sampling procedure with a random start. Inclusion criteria included community dwelling Singapore residents, who could communicate in English, Malay, Mandarin, Tamil, Hokkien or Cantonese. Exclusion criteria included individuals who were visibly too ill or frail to participate, or were unable to provide informed consent due to cognitive impairment as assessed by a screening question during recruitment and continuous observation throughout a face-to-face survey interview.

1
2
3 **Procedures**
4
5   Potential participants were selected from the master list in a sequential order and were contacted in-
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7 person through door-to-door home visits across Singapore. A minimum of three attempts were made to contact
8
9 participants, before moving to the next participant in the master list. Upon initial contact, successfully engaged
10
11 participants were informed of the study's background, rationale and details of their participation. After informed
12
13 consent, participants completed a standardized survey on arts engagement and holistic wellbeing via a 30 to 45-
14
15 minute structured face-to-face interview. Each survey was conducted at the home of the participant, and each
16
17 participant received a monetary incentive of SGD$20 as a token of appreciation. The response rate for this study
18
19 was 59%. 1797 households with current or soon-to-be older adults were contacted to participate in the study; 68
20
21 interested individuals (4%) did not meet the inclusion criteria, 662 potentially eligible participants (37%)
22
23 declined to participate in the study or dropped out, 1067 (59%) eligible and consenting participants were
24
25 recruited and completed the survey.

Ethical considerations

           Ethical approval was obtained through Nanyang Technological University's Institutional Review

Board before study commencement (IRB-2016-05-027). All participants were briefed and interviewed by

trained interviewers who received regular supervision. Individual written consent was obtained prior to data

collection.

Study variables

Arts Engagement

           Arts engagement was measured in terms of active engagement and passive engagement. Passive

engagement was defined as attending art, heritage and culture events (e.g. attending performances, art galleries,

etc.), while active engagement was construed as fully participating in art activities (e.g. painting, dancing,

etc.).[18] A series of standardized ad hoc items were developed to assess the frequency and duration of arts

engagement among study participants, of which included active engagements and passive consumption of eight

art forms - music, dance, theatre, literary arts, visual arts, heritage activities, and craft events. Participants were

asked to recount their active engagements over the past three months and passive engagements over the past six

months since the time of survey to facilitate accurate recall and comprehensive recording of all art activities.

This difference in timeframe assessing passive and active art engagement is due the nature of the engagement;

existing research has shown that the frequency and duration for passive arts engagement are typically much

sparser than active arts engagement,[19] and therefore a longer recall timeframe served to capture sufficient data

for analysis. Overall scores of the total hours of active and passive arts engagement were calculated for each

participant.

Covariates

           To better understand the potential interplay between arts engagement and physical activity on well-

being, a series of standardized items, based on Singapore's National Physical Activities Guideline,[20] was

developed to assess the frequency and intensity of physical activity engagement among study participants. These

items reflect light-intensity lifestyle activities such as walking, moderate-intensity physical activities such as

low-impact aerobics, vigorous-intensity physical activity such as jogging, and strength and balance activities such as Tai Chi. To determine whether medical and demographic variables are potential confounding factors, participant's clinical health information were assessed. Demographic data including age, gender, marital status, family composition, socio-economic status and religion were also collected.

Outcome variables

Outcome variables measured and reported in the current study included quality of life and holistic wellbeing inclusive of the physical, mental, spiritual, and social domains. Quality of life was assessed using the 8-item World Health Organization Quality of Life Instrument (WHOQoL-8).[21] The WHOQoL-8 is a highly reliable scale ($\alpha = 0.86$) that assesses 8 domains of health, energy, daily activities, satisfaction with self, satisfaction with relationships, finance, living conditions and overall quality of life. Scores ranged from 8 – 40, with higher values representing better quality of life. Physical and mental wellbeing were assessed using the Short Form 20 (SF-20) Health Survey.[22] The SF-20 comprises 20 items that assesses health domains including health perceptions, physical role functioning, bodily pain, social functioning, physical functioning and mental health. Item scores were transformed individually and linearly, and were averaged for final domain scores used for analyses. Spiritual wellbeing was assessed using the 12-item Functional Assessment of Chronic Illness Therapy - Spiritual Wellbeing (FACIT-SP-12). The FACIT-SP-12 is a reliable scale ($\alpha = 0.87$) which assesses the three domains of meaning, peace and faith.[23] Possible scores ranged from 0 – 48, where higher scores indicate better spiritual wellbeing. Social wellbeing was assessed using the Interpersonal Support Evaluation List Short Form (ISEL-S).[24] The ISEL-S comprises of 12 items that assess the three domains of appraisal support, belonging support and tangible support and was found to be highly reliable ($\alpha = 0.90$). Overall scores were calculated for the analyses, where higher scores represent better social wellbeing. As Singapore is a multi-lingual society, the questionnaire was prepared in English, Malay, Chinese and Tamil versions. The Chinese versions of the WHOQOL-8, ISEL-S, SF20 and FACIT-SP scales, as well as the Malay version of the WHOQOL-8 were adapted from past studies with Asian older adults.[25-29] The other scales were translated to Malay and Tamil by a professional translator, back-translated, pilot tested and verified by the research team.

Statistical Analysis

Descriptive analyses were performed on all demographic, arts engagement, physical activity and outcome variables. Bivariate correlations and exploratory multiple linear regression analyses were conducted to understand the association between passive and active arts engagement, and various factors of holistic wellbeing. Socio-demographic variables including age, gender, marital status, number of children, highest education achieved, employment status, household income, housing type, and presence of chronic illness were adjusted for in each model.

Propensity score matching (PSM) analysis was employed to minimize selection bias and avoid problems of endogeneity.[30] A propensity score was used to transform all matching variables to a conditional probability to balance the covariate between arts engagement and the comparison group to approach a random distribution and reduce the impact of covariates on the results.[31] Using a logistic regression model, a propensity score was determined for active arts engagement and non-active arts engagement groups, and passive

arts engagement and non-passive arts engagement groups within the study period. The covariates entered into the propensity score included demographic characteristics (age, sex, education, occupation, religion, income, house type) and physical activity variables (light-intensity, moderate-intensity, vigorous-intensity, strength and balance, and all physical activities). Covariates selection in the propensity model was based on the criterion suggested by Brookhart et al.[32] To reduce bias, all meaningful covariates (associated to exposure and outcomes both, or to outcomes only) were decided as a priory to get the optimized propensity score model.[33] The active and passive groups were matched with the comparison group on the logit of the propensity score, using calipers of width equal to 0.2 of the standard deviation.[34] A matching ratio of 1:2 was used for active arts engagement (to get more appropriate comparators as the proportion of active arts engagement was smaller) and 1:1 was used for passive arts engagement. All subsequent analyses were performed in the matched samples by methods appropriate for the analysis of matched data in estimating the impact of active or passive art and the statistical significance. Independent t-tests were used to assess the impact of active or passive art on wellbeing on participants. All statistical analyses were performed by Stata version 13.0 for Windows (StataCorp, Texas, USA). A two-sided p-value less than 0.05 was considered as statistical significance.

RESULTS

Study participants' age ranged from 50 – 95 years (M=64.2, SD=10.0), with 45% males and 81% of Chinese ethnicity, of which are representative of Singapore's older population. 60% of participants reported attending at least one arts and culture activity within a time frame of six months (i.e. passive arts engagements), while 17% of the respondents reported actively participating in at least one arts and culture event within a timeframe of three months (i.e. active arts engagements). Overall, participants spent a median time of 6 hours attending arts events (IQR=11.0; range=0–258 hours) within a six-month time period, and a median time of 11 hours actively engaged in the arts (IQR=27.6; range=0–1015 hours) within a three-month time period. Top reported art forms among arts attendees in this sample included film (28%), heritage-related events (23%) and theatre (25%). As for active arts participants, engagements in visual arts (5%), music (4%) and craftwork (4%) were commonly reported. Detailed demographic information, physical activity levels and scores of all outcome variables are reported in table 1. For subsequent analysis, four outliers were identified and removed due to overtly high arts engagement hours (who may be professional artists or art enthusiasts), hence data from 1,063 participants were used for subsequent analyses. There were no missing data for the variables in this study.

Table 1. Characteristics of Respondents

Demographic Characteristic	N (%)	Variable Information	N (%) / Mean (SD)
Demographic Background		**Arts Engagement Frequency (n, %)**	
Gender		Active Arts Engagement	178 (16.7)
Male	479 (44.9)	Top reported: Visual Art	49 (4.6)
Female	588 (55.1)	Top reported: Music	43 (4.0)
Age at time of survey (years)		Top reported:Craftwork	41 (3.8)
50 - 59	421 (39.5)	Passive Arts Engagement	645 (60.4)
60 - 69	372 (34.9)	Top reported: Film	295 (27.6)
>70	274 (25.7)	Top reported: Theatre	270 (25.3)
Marital Status		Top reported: Heritage-related events	244 (22.9)
Single/Divorced/Widowed	216 (20.2)	**Physical Activity Levels (Mean, SD)**	
Married	851 (79.8)	Light Intensity (Range: 0–57)	5.3 (9.3)
Ethnicity		Moderate Intensity (Range: 0–60)	2.0 (6.1)
Chinese	859 (80.5)	Vigorous Intensity (Range: 0–10)	0.3 (1.0)
Malay	121 (11.3)	Strength and Balance (Range: 0–30)	0.7 (1.5)
Indian	78 (7.3)	Overall Physical Activity (Range: 0–87)	8.2 (12.4)
Others (E.g. Eurasian)	9 (0.8)	**Wellbeing Variables (Mean, SD)**	
Highest Obtained Education		Quality of Life (WHOQOL-8)[b] (Range: 11–40)	31.4 (4.2)
Up to Primary/Elementary School	678 (63.5)	SF20[c] - Health Perception (Range: 0–100)	69.9 (19.6)
Secondary/High School or Above	389 (36.5)	SF20 - Pain (Range: 0–80)	17.4 (20.0)
Employment Status		SF20 - Social Functioning (Range: 0–100)	90.8 (21.4)
Full-time / Self-employed	309 (29.0)	SF20 - Role Functioning (Range: 0–100)	87.9 (29.3)
Part-time employed	148 (13.9)	SF20 - Physical Functioning (Range: 0–100)	86.1 (23.0)
Unemployed or Retired	610 (57.2)	SF20 - Mental Health (Range: 0–100)	81.9 (14.7)
Monthly Household Income (SGD)[a]		Interpersonal Support (ISEL-S)[d] (Range: 12–48)	37.8 (6.6)
< 2,000	412 (38.6)	Appraisal Support Subscale (Range: 4–16)	12.7 (2.4)
2,000 - 3,999	335 (31.4)	Belonging Support Subscale (Range: 4–16)	12.3 (2.6)
≥ 4,000	320 (30.0)	Tangible Support Subscale (Range: 4–16)	12.9 (2.3)
Housing Type		Spiritual Wellbeing (FACIT-Sp-12)[e] (Range: 7–48)	34.0 (8.0)
1 / 2 / 3-room flat	308 (28.9)	Meaning Subscale (Range: 1–16)	12.4 (2.9)
4-room flat	378 (35.4)	Peace Subscale (Range: 2–16)	12.3 (2.8)
5-room/ 3-Gen/ Executive/ Mansionette	277 (26.0)	Faith Subscale (Range: 0–16)	9.3 (3.8)
Condominium and Others	104 (9.7)		

[a] *SGD: Singapore Dollar,* [b]*WHOQOL-8: World Health Organization Quality of Life Instrument (8-item) ,* [c] *SF20: 20-Item Short Form Survey,* [d] *ISEL-S: Interpersonal Support Evaluation List – Short Form;* [e] *FACIT-Sp-12: Functional Assessment of Chronic Illness Therapy - Spiritual Well-Being; The 12-item Spiritual Well-Being Scale*

Results from the correlational analyses indicated that passive arts engagement was associated with better wellbeing measures, specifically, quality of life ($r = 0.233$, $p < 0.0001$), perceived health ($r = 0.174$, $p < 0.0001$), social functioning ($r = 0.106$, $p = 0.001$), mental health ($r = 0.124$, $p < 0.0001$), spiritual wellbeing ($r = 0.162$, $p < 0.0001$) and interpersonal support ($r = 0.172$, $p < 0.0001$). Furthermore, active engagements in the arts were associated with better quality of life ($r = 0.177$, $p < 0.0001$), health perceptions ($r = 0.130$, $p < 0.0001$), role functioning ($r = 0.078$, $p = 0.011$), social functioning ($r = 0.100$, $p = 0.001$) and mental health ($r = 0.154$, $p < 0.0001$), as well as enhanced spiritual wellbeing ($r = 0.201$, $p < 0.0001$) and interpersonal support ($r = 0.116$, $p < 0.0001$). After adjusting for covariates in each model, findings from exploratory regression analyses indicated that passive engagement in the arts was a significant independent predictor of better quality of life ($\beta = 0.166$, $p < 0.0001$), health perceptions ($\beta = 0.146$, $p < 0.0001$), mental health ($\beta = 0.095$, $p = 0.002$), spiritual wellbeing ($\beta = 0.128$, $p < 0.0001$) and interpersonal support ($\beta = 0.101$, $p = .0003$). Similarly, active engagement in the arts were also a significant predictor of quality of life ($\beta = 0.139$, $p < 0.0001$), health perceptions ($\beta = 0.078$, $p = 0.006$) and spiritual wellbeing ($\beta = 0.065$, $p = 0.023$). Please refer to table 2 for more details.

Balancing information before and after propensity score matching is presented in the table 3. After matching, a total of 444 (treatment = 176 & control = 268) cohort participants were included in the analysis for active group and 730 (treatment = 365 & control = 365) were included in the analysis for passive group respectively. All included covariates achieved balance after matching in the PSM analysis except for age and some physical activity components, however these differences were minimal. For the active engagement group, the median bias prior to matching was 22.8% and this value was reduced to 1.4% after matching. The median bias prior to matching for the passive engagement group was 15.1% and was reduced to 8.6% after matching.

Detailed findings of the t-tests conducted are presented in table 4. Results from independent-samples t-tests revealed that participants who engaged in the arts scored significantly better in multiple measures of wellbeing. For the passive engagement group, participants reported a significantly higher quality of life [$t(728)=-3.35$, $p=0.0008$, $d=0.25$] and perceived health scores [$t(728)=-2.21$, $p=0.0227$, $d=0.16$] than matched controls. Although there were no significant differences in overall social wellbeing, these arts attendees reported an enhanced sense of belonging [$t(728)=-2.17$, $p=0.03$, $d=0.16$] in the social wellbeing subscale than non-arts attendees. Independent-sample t-tests conducted with the active arts engagement group also revealed significant mean differences in quality of life [$t(442)=-3.68$, $p=0.0003$, $d=0.36$], perceived health [$t(442)=-2.59$, $p=0.0099$, $d=0.25$] and overall spiritual wellbeing [$t(442)=-3.75$, $p=0.0002$, $d=0.37$]. Moreover, participants who actively participated in the arts also reported greater spiritual wellbeing subscale scores in meaning in life [$t(442)= -5.02$, $p<0.0001$, $d=0.50$] as well as sense of peace [$t(442)=-3.72$, $p=0.0002$, $d=0.36$] in comparison to matched controls. Finally, although marginally significant, active arts participants also reported better social functioning [$t(442)=-1.68$, $p=0.0939$, $d=0.17$] and mental health [$t(442)=-1.84$, $p=0.0668$, $d=0.18$].

Table 2. Spearman Correlations and Multiple Regression Analyses Predicting Wellbeing

Wellbeing Measures	Passive Arts Engagement					Active Arts Engagement				
	Spearman Correlation		Multiple Regression			Spearman Correlation		Multiple Regression		
	r	p value	β	p value	Adj. R²	r	p value	β	p value	Adj. R²
Quality of Life (WHOQOL-8)	0.233	<0.0001*	0.166	<0.0001*	0.150	0.177	<0.0001*	0.139	<0.0001*	0.142
Holistic Health (SF20)										
SF20 - Health Perception	0.174	<0.0001*	0.146	<0.0001*	0.179	0.130	<0.0001*	0.078	0.006*	0.163
SF20 - Role Functioning	0.050	0.101	…	…	…	0.078	0.011*	…	…	…
SF20 - Pain Domain	-0.010	0.750	…	…	…	-0.024	0.430	…	…	…
SF20 - Social Functioning	0.106	0.0001*	…	…	…	0.100	0.0001*	…	…	…
SF20 - Physical Function	0.050	0.103	…	…	…	0.027	0.373	…	…	…
SF20 - Mental Health	0.124	<0.0001*	0.095	0.002*	0.069	0.154	<0.0001*	0.057	0.058	0.063
Spiritual Wellbeing (FACIT-SP-12)	0.162	<0.0001*	0.128	<0.0001*	0.177	0.201	<0.0001*	0.065	0.023*	0.164
Meaning Subscale	0.164	<0.0001*	0.121	<0.0001*	0.191	0.244	<0.0001*	0.081	0.004*	0.183
Peace Subscale	0.153	<0.0001*	0.123	<0.0001*	0.144	0.205	<0.0001*	0.094	0.001*	0.138
Faith Subscale	0.096	0.002*	0.084	0.003*	0.171	0.095	0.002*	0.004	0.896	0.164
Interpersonal Support (ISEL-S)	0.172	<0.0001*	0.101	0.0003*	0.180	0.116	<0.0001*	0.036	0.205	0.172
Appraisal Subscale	0.126	<0.0001*	0.086	0.003*	0.133	0.096	0.002*	0.030	0.299	0.127
Belonging Subscale	0.190	<0.0001*	0.123	<0.0001*	0.163	0.117	<0.0001*	0.043	0.134	0.150
Tangible Subscale	0.135	<0.0001*	0.059	0.039*	0.144	0.106	0.001*	0.022	0.439	0.141

*N= 1063, *p<0.05, Note: Variables which satisfied the normality tests are reported in the table; Covariates entered: age, gender, marital status, number of children, education, presence of religious belief, employment status, monthly household income, housing type, presence of chronic illness*

Table 3. Distribution of Balance for Covariates Before and After Matching by Propensity Score Matching (PSM) in Passive and Active Engagement Groups

Balance variables	Passive Engagement						Active Engagement					
	Before matching (n = 1063)			After matching (n = 730)			Before matching (n = 1063)			After matching (n = 444)		
	Passive Group (n = 642)	Non-Passive Group (n = 421)	Mean difference	Passive Group (n = 365)	Non-Passive Group (n = 365)	Standardised mean difference	Active Group (n = 176)	Non-Active Group (n =887)	Mean difference	Active Group (n = 176)	Non-Active Group (n =268)	Standardised mean difference
Age (years)	62.57	66.73	-4.15	66.47	65.02	1.46	61.60	64.74	-3.14	61.60	61.09	0.51
Sex												
Male respondents	0.42	0.49	-0.07	0.52	0.47	0.05	0.38	0.46	-0.09	0.38	0.36	0.01
Marital Status												
Married	0.81	0.77	0.04	0.77	0.79	-0.02	0.86	0.79	0.07	0.86	0.86	0.00
Highest Obtained Education												
Elementary school	0.49	0.56	-0.07	0.64	0.58	0.06	0.43	0.54	-0.11	0.43	0.43	-0.01
High School or Higher	0.43	0.27	0.15	0.23	0.31	-0.08	0.53	0.33	0.20	0.53	0.52	0.01
Ethnicity												
Chinese ethnic group	0.81	0.79	0.02	0.78	0.80	-0.02	0.84	0.80	0.04	0.84	0.86	-0.03
Religious Belief												
Have religious belief	0.88	0.86	0.02	0.86	0.86	-0.01	0.88	0.87	0.01	0.88	0.88	0.00
Employment Status												
Part-time employed	0.16	0.11	0.05	0.10	0.13	-0.03	0.20	0.13	0.08	0.20	0.19	0.02
Full-time or self-employed	0.32	0.25	0.07	0.25	0.27	-0.02	0.32	0.29	0.03	0.32	0.32	0.00
Monthly Household Income (SGD)												
1,000 - 2,999	0.29	0.32	-0.03	0.36	0.32	0.04	0.24	0.31	-0.08	0.24	0.24	0.00
>3,000	0.51	0.39	0.13	0.37	0.42	-0.05	0.54	0.45	0.09	0.54	0.53	0.01
Housing Type												
3-4 room HDB Flat	0.55	0.62	-0.06	0.65	0.62	0.03	0.47	0.60	-0.13	0.47	0.46	0.01
5 room HDB Flat and others	0.38	0.31	0.07	0.28	0.32	-0.04	0.49	0.33	0.17	0.49	0.50	0.00
Physical Activity Levels (Hours)												
Light Intensity	6.49	3.43	3.06	2.52	3.69	-1.17	9.09	4.52	4.57	9.09	8.97	0.13
Moderate Intensity	2.46	1.42	1.04	1.02	1.59	-0.56	3.30	1.80	1.50	3.30	3.33	-0.03
Vigorous Intensity	0.03	0.16	-0.13	0.11	0.16	-0.05	0.51	0.20	0.31	0.51	0.53	-0.02
Strength and Balance	0.78	0.51	0.26	0.46	0.56	-0.11	1.00	0.61	0.39	1.00	0.84	0.16
All Physical Activities	10.05	5.52	4.52	4.11	6.01	-1.90	13.91	7.13	6.78	13.91	13.68	0.23

Table 4. Group Differences in Wellbeing Scores

Wellbeing	Passive Arts Engagement[a]				Active Arts Engagement[b]			
	Passive (Mean ± SD)	Control (Mean ± SD)	p	Effect Size	Active (Mean ± SD)	Control (Mean ± SD)	p	Effect Size
Quality of Life (WHOQOL-8)	31.5 ± 4.15	30.5 ± 4.2	0.0008*	0.25	33.0 ± 4.16	31.5 ± 4.14	0.0003*	0.36
Short Form Health Survey (SF-20)								
SF20 - Health Perception	69.6 ± 19.9	66.3 ± 21.1	0.028*	0.16	75.5 ± 18.2	70.7 ± 19.3	0.0099*	0.25
SF20 - Role Functioning	85.4 ± 31.2	86.4 ± 31.7	0.659	0.03	92.8 ± 24.2	91.1 ± 26.1	0.512	0.06
SF20 - Pain Domain	18.1 ± 20.9	17.8 ± 20.7	0.859	0.01	16.7 ± 20.6	17.9 ± 19.6	0.538	0.06
SF20 - Social Functioning	90.9 ± 19.6	88.9 ± 24.5	0.230	0.09	95.6 ± 14.7	92.8 ± 18.7	0.094	0.17
SF20 - Physical Function	84.9 ± 22.2	84.4 ± 25.2	0.785	0.02	89.2 ± 18.6	88.5 ± 20.9	0.715	0.04
SF20 - Mental Health	81.2 ± 14.8	80.5 ± 15.4	0.532	0.05	86.0 ± 13.1	83.6 ± 14.0	0.067	0.18
Interpersonal Support (ISEL-S)	37.4 ± 6.3	36.8 ± 6.4	0.253	0.08	39.4 ± 6.9	38.7 ± 6.4	0.273	0.11
Appraisal Subscale	12.4 ± 2.3	12.4 ± 2.4	0.751	0.02	13.1 ± 2.6	12.9 ± 2.4	0.483	0.07
Belonging Subscale	12.2 ± 2.5	11.8 ± 2.6	0.030*	0.16	12.9 ± 2.6	12.6 ± 2.4	0.246	0.11
Tangible Subscale	12.7 ± 2.2	12.6 ± 2.3	0.658	0.03	13.4 ± 2.5	13.1 ± 2.2	0.262	0.11
Spiritual Wellbeing (FACIT-Sp-12)	33.5 ± 8.0	33.1 ± 8.1	0.496	0.05	37.5 ± 7.2	34.7 ± 7.7	0.0002*	0.37
Meaning Subscale	12.2 ± 2.8	12.1 ± 3.0	0.908	0.01	13.9 ± 2.3	12.6 ± 2.8	<0.0001*	0.50
Peace Subscale	12.1 ± 2.7	11.9 ± 3.0	0.419	0.06	13.5 ± 2.6	12.5 ± 2.7	0.0002*	0.36
Faith Subscale	9.3 ± 3.9	9.0 ± 3.9	0.464	0.05	10.1 ± 4.0	9.6 ± 3.8	0.211	0.12

[a]$n = 730$, [b]$n = 444$; *$p<0.05$

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DISCUSSION

This was the first-ever empirical research that examined arts engagements and its impact on holistic wellbeing among current and future elderly populations in Asia using naturalistic observational data with PSM analysis. This study established significantly strong causal relationships between arts engagements (both passive and active engagements) and numerous domains of holistic wellbeing in a naturalistic sample of older adults in Asia. These findings revealed that by passively engaging in the arts, older adults experienced significantly higher quality of life, better perceived health and greater social connectedness as compared to non-art attendees. In addition, the results further showed that older adults who actively engaged in the arts experienced significantly enhanced quality of life, better perceived health, stronger spiritual wellness, life meaning and peace with a medium effect size, as compared to non-art participants. By employing a stratified random sampling method, the sample characteristics were as a result highly representative of the Singaporean Population statistics and thus generalizable to the Asian Singaporean population of older adults.[35] Furthermore, through propensity score matching, arts participants were systematically matched on multiple covariates with respondents who did not engage in the arts. This allowed for meaningful comparisons between groups, usually lacking in the literature on arts engagement and health. These findings provide an important cross-cultural understanding on the relationship between arts and wellbeing in Asia while contributing to the growing literature on the subject matter on the international stage.[36]

The inner workings between arts and wellness can be linked to the literature on creativity, self-mastery, relational aesthetics and neurological sciences. Arts engagement fosters an empowering process of creativity and autonomy that cultivates mindful-awareness, self-understanding and new insights.[37] This in turn facilitates motivation for narrative identity processing,[38] a constructive reflection process of character building that fosters life meaning and self-affirmation, leading to the development of self-mastery.[39, 40] Through arts engagements, individuals also encounter relational aesthetics, an experience of emotional connection via metaphoric dialogue with the arts and the artists that broadens perspectives and nurtures diversity, while inspiring human connections, empathy and compassionate citizenry.[41,42] Arts engagement may also have a role to play in stimulating the parasympathetic nervous system, leading to a greater sense of peace and relaxation.[43] Finally, neurological literature has illustrated the effects of arts as a means for stimulating neuroplasticity and building cognitive reserve.[44,45] As such, it is evident that the arts can positively impact various domains of wellbeing through numerous psychosocial processes, particularly for older adults whose sense of identity and personhood progressively decline with the onset of old age, worsening health and diminishing social networks.[46] Future arts-based elderly care programmes may target these avenues and pathways for wellness promotion.

Study findings further clearly reveal that varying depths of arts engagements can impact different domains of holistic wellness among the aged. Passive or active exposure to the arts can bring about quality of life and subjective health benefits. Attending art events can reap social and relational benefits for tackling social isolation, while creating art can invite intrinsic motivational benefits that lead to spiritual fulfillment and growth. From a policy perspective, this translates into multiple entry points for attracting and maintaining art participation among current and future generations of elderly. Thus, considerations for a formal and sustainable structure that incorporates participatory art initiatives and programmes into aged care services, while ensuring

proficient training of more community art workers to support these works, must be made, as this can be a cost-effective way to promote healthy, creative and meaningful ageing.

Despite the positive effects of creative arts engagement on health, it has been repeatedly found that promoting engagement in the arts among the elderly is difficult, as participation in the arts generally declines with age, most progressively among individuals reaching age of 65, and most markedly for those aged 75 and above.[47] Similar findings have also been reported in Singapore, where older adults aged 60 and above had the lowest art attendance and art participation rates among all age cohorts.[48] Within this sample, art participation rates among adults aged 50 and above was 17%. This trend is disconcerting given the fact that the arts can play a significant role in supporting well-being in old-age. From a practice perspective, participatory arts programmes and initiatives may include public education on the benefits of the arts, advocacy campaigns to promote arts engagements, art-based psychosocial care programming designed for community and residential care settings, as well as collaboration with arts and cultural heritage intuitions in developing arts programmes that are fitting to the needs and interests of older adults. Practitioners may also consider integrating passive art activities to enhance social programmes for older adults. Moreover, health and social care providers can consider the arts as a non-medical, non-pharmaceutical agent for mental health and quality of life enhancement. Finally, the arts may also be considered as a gateway to support stronger social networks for tackling the public health problem of loneliness, and this can be achieved through programmes that use the arts as conduits for outreach, relational bonding and community building.

The results of this study, although theoretically and practically appealing, are not without its limitations. First, all potential confounders were balanced in the PSM except for age and frequency of light intensity physical activity, hence caution must be exercised when interpreting the results. Second, the current study employed cross-sectional survey data with its own limitations, thus, future studies should consider implementing a robust experimental or longitudinal research design to obtain a deeper understanding of the causal and directional effects of arts engagement. Third, the psychometric measures used are subjective in nature, and future research can consider objective measures such functional magnetic resonance imaging (fMRI).

In conclusion, the arts can play a significant role in sustaining a healthy, active and resilient elderly populace with greater cost-efficiency than traditional medicine and health service models. Under the rubric of rapid population ageing, the need for more evidence-driven arts promotion initiatives to foster active and creative ageing, as well as greater art-based psychosocial care for the elderly is urgently warranted in Asia and around the globe.

AUTHOR CONTRIBUTIONS

In terms of author contributions, AHYH, MHRH, JSP and EO designed the study and obtained funding, SHXM carried out literature search and data collection, RCB carried out data analysis, all authors contributed to data interpretation, as well as the writing and revision of the manuscript.

ROLE OF THE FUNDING SOURCE

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EXCLUSIVE LICENCE

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The Arts for Ageing Well: A Propensity Score Matching Analysis of the Effects of Arts Engagements on Holistic Wellbeing among Asian Elderly Population

STROBE Statement—Checklist of items that should be included in reports of *cross-sectional studies*

	Item No	Recommendation	Reported on Manuscript Page (Section)
Title and abstract	1	(*a*) Indicate the study's design with a commonly used term in the title or the abstract	1 (Title)
		(*b*) Provide in the abstract an informative and balanced summary of what was done and what was found	2 (Abstract)
Introduction			
Background/rationale	2	Explain the scientific background and rationale for the investigation being reported	3,4 (Introduction)
Objectives	3	State specific objectives, including any prespecified hypotheses	4 (Research Objectives)
Methods			
Study design	4	Present key elements of study design early in the paper	5 (Study Design and Participants)
Setting	5	Describe the setting, locations, and relevant dates, including periods of recruitment, exposure, follow-up, and data collection	5 (Study Design and Participants)
Participants	6	(*a*) Give the eligibility criteria, and the sources and methods of selection of participants	5 (Study Design and Participants)
Variables	7	Clearly define all outcomes, exposures, predictors, potential confounders, and effect modifiers. Give diagnostic criteria, if applicable	6 (Study variables)
Data sources/ measurement	8*	For each variable of interest, give sources of data and details of methods of assessment (measurement). Describe comparability of assessment methods if there is more than one group	6 (Study variables)
Bias	9	Describe any efforts to address potential sources of bias	7,8 (Statistical Analysis)
Study size	10	Explain how the study size was arrived at	5 (Study Design and Participants)
Quantitative variables	11	Explain how quantitative variables were handled in the analyses. If applicable, describe which groupings were chosen and why	8 (Statistical Analysis)
Statistical methods	12	(*a*) Describe all statistical methods, including those used to control for confounding	7,8 (Statistical Analysis)
		(*b*) Describe any methods used to examine subgroups and interactions	7,8 (Statistical Analysis)
		(*c*) Explain how missing data were addressed	9 (Results)
		(*d*) If applicable, describe analytical methods taking account of sampling strategy	5 (Study Design and Participants)
		(*e*) Describe any sensitivity analyses	N.A. All known confounders were adjusted using the Propensity Score Methods. Hence there is no need to perform a sensitivity analysis.

The Arts for Ageing Well: A Propensity Score Matching Analysis of the Effects of Arts Engagement on Holistic Wellbeing among Elderly Population in Asia

Results			
Participants	13*	(a) Report numbers of individuals at each stage of study—eg numbers potentially eligible, examined for eligibility, confirmed eligible, included in the study, completing follow-up, and analysed	5,6 (Methods; Procedures)
		(b) Give reasons for non-participation at each stage	5,6 (Methods; Procedures)
		(c) Consider use of a flow diagram	N.A.
Descriptive data	14*	(a) Give characteristics of study participants (eg demographic, clinical, social) and information on exposures and potential confounders	8 (Results), 9 (Table 1)
		(b) Indicate number of participants with missing data for each variable of interest	9 (Results)
Outcome data	15*	Report numbers of outcome events or summary measures	8 (Results), 9 (Table 1)
Main results	16	(*a*) Give unadjusted estimates and, if applicable, confounder-adjusted estimates and their precision (eg, 95% confidence interval). Make clear which confounders were adjusted for and why they were included	11 (Table 3)
		(*b*) Report category boundaries when continuous variables were categorized	N.A.
		(*c*) If relevant, consider translating estimates of relative risk into absolute risk for a meaningful time period	N.A.
Other analyses	17	Report other analyses done—eg analyses of subgroups and interactions, and sensitivity analyses	N.A. Please refer to *item 12e*
Discussion			
Key results	18	Summarise key results with reference to study objectives	12 (Discussion)
Limitations	19	Discuss limitations of the study, taking into account sources of potential bias or imprecision. Discuss both direction and magnitude of any potential bias	14 (Discussion)
Interpretation	20	Give a cautious overall interpretation of results considering objectives, limitations, multiplicity of analyses, results from similar studies, and other relevant evidence	13 (Discussion)
Generalizability	21	Discuss the generalizability (external validity) of the study results	12 (Discussion)
Other information			
Funding	22	Give the source of funding and the role of the funders for the present study and, if applicable, for the original study on which the present article is based	Please see application

*Give information separately for exposed and unexposed groups.

The Arts for Ageing Well: A Propensity Score Matching Analysis of the Effects of Arts Engagement on Holistic Wellbeing among Elderly Population in Asia

Note: An Explanation and Elaboration article discusses each checklist item and gives methodological background and published examples of transparent reporting. The STROBE checklist is best used in conjunction with this article (freely available on the Web sites of PLoS Medicine at http://www.plosmedicine.org/, Annals of Internal Medicine at http://www.annals.org/, and Epidemiology at http://www.epidem.com/). Information on the STROBE Initiative is available at www.strobe-statement.org.

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The Arts for Ageing Well: A Propensity Score Matching Analysis of the Effects of Arts Engagements on Holistic Wellbeing among Asian Elderly Population

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The Arts for Ageing Well: A Propensity Score Matching Analysis of the Effects of Arts Engagements on Holistic Wellbeing among Asian Elderly Population

Andy Hau Yan Ho[1, 2*], Stephanie Hilary Xinyi Ma[1], Moon-Ho Ringo Ho[1], Joyce Shumin Pang[1], Emily Ortega[3], Ram Chandra Bajpai[2]

[1]Psychology Programme, School of Social Sciences, Nanyang Technological University, Singapore.

[2]Centre for Population Health Sciences, Lee Kong Chian School of Medicine, Nanyang Technological University, Singapore.

[3]Psychology Programme, School of Humanities and Behavioral Sciences, Singapore University of Social Sciences, Singapore.

* Correspondence to: Dr Andy Hau Yan Ho, School of Social Sciences, 48 Nanyang Avenue, HSS-04-03, Singapore 639818. Email: andyhyho@ntu.edu.sg   Tel: +65 6316 8943

(Manuscript Word Count: 4,845)

Abstract

Objective: To assess the frequency and intensity of arts engagement inclusive of active and passive engagements in arts, culture and heritage activities among Singaporean adults aged 50 and above, and examine the relationships between participatory art and holistic wellbeing.

Design: Cross-sectional stratified household survey.

Setting: All residential areas across Singapore's Central, East, North, South and West Regions.

Participants: 1,067 community-dwelling, Singaporean older adults between the ages of 50-95 years were recruited.

Primary and secondary outcome measures: Respondents completed a self-reported questionnaire, consisting of standardized ad hoc items assessing the frequencies and durations of active and passive participatory arts engagement, as well as validated psychometric assessments on psycho-socio-spiritual health including the primary outcome measure on quality of life, and the secondary outcome measures on physical, psychological, emotional, spiritual, and social well-being. Socio-demographic information, as well as frequency and intensity of physical activity were also collected.

Results: Passive engagement (60%) and active engagement (17%) in the arts were associated with better holistic wellness and social support. Specifically, findings from the propensity score matching (PSM) and independent t-test analyses revealed that adults aged 50 and above who attended arts and culture-related events experienced higher quality of life [$t(728)=3.35$, $p=0.0008$, $d=0.25$], perceived health [$t(728)=2.21$, $p=0.0277$, $d=0.16$], and sense of belonging [$t(728)=2.17$, $p=0.03$, $d=0.16$], as compared to non-art attendees. Moreover, those who engaged in participatory arts experienced greater quality of life [$t(442)=3.68$, $p=0.0003$, $d=0.36$], self-rated health [$t(442)=2.59$, $p=0.0099$, $d=0.25$], spiritual wellbeing [$t(442)=3.75$, $p=0.0002$, $d=0.37$], meaning in life [$t(442)=5.02$, $p<0.0001$, $d=0.50$], and sense of peace [$t(442)=3.72$, $p=0.0002$, $d=0.36$], as compared to non-art participants.

Conclusion: This study provided robust evidence to support a significant causal relationship between arts engagements and holistic wellbeing. Recommendations for art-based public health and elderly care research, practice and policy are discussed.

Keywords: *Holistic wellbeing; Creative ageing; Participatory art; Propensity score matching; Public Health, Mental Health; Asia*

STRENGTHS AND LIMITATIONS OF THIS STUDY

- First-ever empirical research to date that examined arts engagements and its impact on holistic wellbeing in Asia using naturalistic observational data.
- Sample was a large, representative older adult population in Singapore
- Propensity score matching (PSM) analysis was employed to minimize selection bias and avoid problems of endogeneity, allowing for comparisons between art-active groups and non-art-active groups.
- A wide range of art forms were assessed, of which included active engagements and passive consumption of eight art forms - music, dance, theatre, literary arts, visual arts, heritage activities, film, and craft events.
- The current study employed cross-sectional survey data that assessed participants at a single time point, and thus is not possible to rule out the potentiality of reverse causality.

INTRODUCTION

Asia is ageing at a much faster rate than anywhere else in the world.[1] In Singapore specifically, the proportion of adults aged 65 and above has more than doubled in the past two decades from 6% in 1990 to 13% in 2017. This trend will exponentially increase to approximately 25% by 2030.[2] Longevity, however, does not necessarily reflect better health at old age. According to recent statistics, 60% of Singaporeans aged 50 and above suffered from a chronic illness such as diabetes, heart disease and stroke, while 10% of adults aged 60 and above, as well as 50% of adults aged 85 and above were affected by dementia.[3, 4] Additionally, 51% of Singaporeans above the age of 60 reported feelings of loneliness and were at a greater risk of mortality.[5] These numbers reflect greater demands for health and social care services among the aged in the foreseeable future.

While traditional biomedical models have focused predominantly on supporting elderly health through curative interventions and rehabilitation services, contemporary public health approaches emphasize a health-promoting paradigm for maintaining and elevating holistic wellbeing, through cultivating personal autonomy, social participation and community involvement.[6] One has to look no further than to the Arts to realize its vital significance in cultivating these goals, as engagements in the cultural heritage of music, dance, theatre, literature as well as the visual arts have been known to have tangible effects on health and quality of life, whereby the agents of creativity and imagination can help "keep individual resilience, aid recovery and foster a flourishing society" (p.3).[7] Despite the extensive use of the arts for its therapeutic properties across history, research investigating healthy and active ageing through arts engagement were fairly recent.[8]

To consolidate existing research that investigated the relationship between arts engagement, health wellbeing and ageing, a literature search was conducted through PsycInfo, Web of Science, Social Science Citation Index, PubMed, and Medline. Relevant reports and studies published by governments and related organizations were also examined. Overall, the research team found robust evidence to support the efficacy of the arts in promoting wellness. Most notably, the Creative Health inquiry report published in the United Kingdom, which examined over 1,000 peer-reviewed and grey literature, concluded that not only can the arts bring various health and mental health benefits to people of all ages, it can also serve to address health and social care challenges in greater society such as ageing, longer-term conditions and loneliness.[9] Among studies that focused on community dwelling older adults, multiple reviews of empirical research that studied the

relationships between art-based interventions and healthy ageing revealed that active engagements in various forms of art produced positive cognitive, affective, and quality of life outcomes.[10,11] For instance, a randomized controlled trial on participatory singing activities reported its effectiveness in enhancing quality of life, and reducing anxiety and depression among older intervention participants. [12] Moreover, the Museums on Prescription Study showed that cultural heritage engagements were effective in improving psychological and social wellbeing.[13,14] Moreover, the efficacy of the arts in the treatment of mental health conditions, as well as support for the treatment of various chronic health conditions were well documented.[15,16] Numerous systematic reviews also suggested that various forms of participatory art activities were beneficial for persons with dementia living in residential care settings, serving to enhance cognitive processes, attention, mood and memory.[17, 18] Specifically, musical activities yielded better episodic memory and mood among patients with early dementia in a recent randomized controlled trial [19]. Finally, although limited, art and cultural heritage-based intervention studies with Asian populations have also shown similar positive results in psychological wellbeing.[20]

Despite robust evidence on the benefits of art-based interventions applied in the abovementioned settings, much less research has examined the impact of arts engagements in naturalistic settings.[21] In fact, many studies employed simple pre-and-post intervention designs without control groups, while others employed relatively small sample sizes that prevented meaningful comparisons.[11] Often, participants of these studies were recruited via convenience sampling rather than random sampling, potentially resulting in response biases.[15] With a rapidly ageing population around the globe and in Asia, there is a need to understand the landscape of arts engagement and to investigate the relationships between arts engagement and holistic well-being for advancing practices and policies that promote healthy and creative ageing. The "Arts for Ageing Well" study was the first-ever attempt to critically address this important knowledge gap by utilizing a holistic investigative approach with both quantitative and qualitative methodologies for exploring and understanding the notion of ageing well with the arts in Asia. This article reports the quantitative findings of the Arts for Ageing Well study.

Research Objectives

The specific objectives of this study were to (i) assess the frequency and intensity of arts engagement inclusive of active and passive engagements in music, dance, theatre, literary arts, visual arts, film, heritage events and activities, and craft events among Singaporean adults aged 50 and above, and to (ii) examine the relationships between participatory art and holistic well-being in terms quality of life, physical, psychological, emotional, spiritual, and social well-being.

METHODS

Study Design and Participants

1,067 participants were recruited between July 2016 and February 2017 across all regions of Singapore via a cross-sectional stratified random household survey to ensure sample representativeness of the national population. Sample size calculation was based on power analysis; a sample size of 1,067 allowed for ± 3% accuracy at the 95% confidence level. A sampling frame comprising all residential dwelling units with at least one resident aged 50 and above, spanning across all geographical areas demarcated by the Urban

Redevelopment Authority as residential areas that covered Singapore's Central, East, North, South and West Regions, was obtained from the Singapore Department of Statistics. Dwelling units were grouped into four non-overlapping strata according to age group, and were further stratified into gender, ethnicity, and housing types. Based on the resulting Master List, a fixed number of dwelling units were selected by a systematic sampling procedure with a random start. The inclusion criteria were community dwelling Singapore residents, who were able to communicate in either English, Malay, Mandarin, Tamil, Hokkien or Cantonese. The exclusion criteria were individuals who were visibly too ill or frail to participate or were unable to provide informed consent due to cognitive impairment as assessed by a screening question during recruitment and continuous observation throughout a face-to-face survey interview.

Procedures

Potential participants were selected from the master list in a sequential order and were contacted in-person through door-to-door home visits across Singapore. A minimum of three attempts were made to contact participants, before moving to the next participant in the master list. Upon initial contact, successfully engaged participants were informed of the study's background, rationale and details of their participation. Only one adult above the age of 50 was recruited from each randomly selected household. After informed consent, participants completed a standardized survey on arts engagement and holistic wellbeing via a 30 to 45-minute structured face-to-face interview. Each survey was conducted at the home of the participant, and each participant received a cash voucher of SGD$20 upon completion of the survey. The response rate for this study was 59%. 1,797 households with current or soon-to-be older adults were contacted to participate in the study; 68 interested individuals (4%) did not meet the inclusion criteria, 662 potentially eligible participants (37%) declined to participate in the study or dropped out, 1,067 (59%) eligible and consenting participants were recruited and completed the survey.

Ethical considerations

Ethical approval was obtained through Nanyang Technological University's Institutional Review Board before study commencement (IRB-2016-05-027). All participants were briefed and interviewed by trained interviewers who received regular supervision. Individual written consent was obtained prior to data collection.

Patient and Public Involvement

Research participants were not involved in the development of the research question, design, recruitment processes and conduct of the study. The findings of the study were disseminated locally via press coverage, and media interviews and conference presentations.

Study variables

Arts Engagement

A series of standardized ad hoc items were developed to assess the frequency and duration of arts engagement among study participants, of which included active engagements and passive consumption of eight specific art forms – music, dance, theatre, literary arts, visual arts, heritage activities, film and handicraft.[22]

Arts engagement was measured in terms of active engagement and passive engagement. Active engagement was construed as the active participation in art, heritage and cultural activities such as creating, while passive engagement referred to passive behaviors such as attending, viewing or listening.[23] Some examples of engagement in the study included attendance or participation in theatre events (e.g. attending musicals, performance in traditional theatre), music activities (e.g. listening to classical music, playing a musical instrument), dance performances (e.g. watching a ballet performance, participating in line dancing classes), visual arts activities (e.g. visiting art fairs, doing photography), heritage-related activities (e.g. visiting heritage buildings and monuments, providing guided cultural tours to others), literary arts-related events (e.g. attending a book launch, writing biographies), film-related events (e.g. attending a film festival, participating in a local film production) and craft activities (e.g. teaching embroidery classes). Participants were asked to recount their active engagements over the past three months and passive engagements over the past six months since the time of survey to facilitate accurate recall and comprehensive recording of all art activities. This difference in timeframe in assessing passive and active art engagement was due to the nature of engagement; existing research has shown that the frequency and duration for passive arts engagement were typically much sparser than active arts engagement,[24] and therefore a longer recall timeframe served to capture sufficient data for analysis. Overall scores of the total hours of active and passive arts engagement were calculated for each participant.

Covariates

To better understand the potential interplay between arts engagement and physical activity on well-being, a series of standardized items based on Singapore's National Physical Activities Guidelines,[25] was developed to assess the frequency and intensity of physical activity engagement among study participants. These items reflect light-intensity lifestyle activities such as walking, moderate-intensity physical activities (e.g. low-impact aerobics), vigorous-intensity physical activity (e.g. jogging), and strength and balance activities (e.g. Tai Chi). To determine whether medical and demographic variables were potential confounding factors, participant's clinical health information were assessed via self-reported presence of chronic illness and time since diagnosis. Demographic data including age, gender, marital status, family composition, socio-economic status and religion were also collected.

Outcome variables

Outcome variables measured and reported in the current study included quality of life and holistic wellbeing inclusive of the physical, mental, spiritual, and social domains. Quality of life was assessed using the 8-item World Health Organization Quality of Life Instrument (WHOQoL-8).[26] The WHOQoL-8 is a highly reliable 8-item scale ($\alpha = 0.86$) that measured participants' perceived quality of life domains including health, energy for everyday life, ability to perform daily activities, satisfaction with self, satisfaction with relationships, personal finances, living conditions and overall quality of life. Scores ranged from 8 – 40, with higher values representing better quality of life. Physical and mental wellbeing were assessed using the Short Form 20 (SF-20) Health Survey.[27] The SF-20 comprised of 20 items that measured six health domains including the subscales of health perceptions, physical role functioning, presence of bodily pain, perceived social functioning, physical functioning and mental health. Item scores were transformed individually and linearly, and were averaged for final domain scores used for analyses. Higher values represented better self-reported health for all subscales,

except for the bodily pain subscale, where higher values represented more reported bodily pain. Spiritual wellbeing was assessed using the 12-item Functional Assessment of Chronic Illness Therapy - Spiritual Wellbeing (FACIT-SP-12). The FACIT-SP-12 is a reliable scale ($\alpha = 0.87$) which measured the three domains of meaning, peace and faith.[28] Possible scores ranged from $0 – 48$, with higher scores indicating better spiritual wellbeing. Social wellbeing was assessed using the Interpersonal Support Evaluation List Short Form (ISEL-S).[29] The 12-item ISEL-S is a highly reliable scale ($\alpha = 0.90$) which measured the three domains of appraisal support, belonging support and tangible support. Overall scores were calculated for the analyses, with higher scores representing better social wellbeing. As Singapore is a multi-lingual society, the questionnaire was prepared in English, Malay, Chinese and Tamil. The Chinese versions of the WHOQOL-8, ISEL-S, SF20 and FACIT-SP scales, as well as the Malay version of the WHOQOL-8 were adapted from past studies with Asian older adults.[30-34] The other scales were translated to Malay and Tamil by a professional translator, back-translated, pilot tested and verified by the research team.

Statistical Analysis

Descriptive analyses were performed on all demographic, arts engagement, physical activity and outcome variables. Bivariate correlations and exploratory multiple linear regression analyses were conducted to understand the association between passive and active arts engagement, and various factors of holistic wellbeing. Socio-demographic variables including age, gender, marital status, number of children, highest education achieved, employment status, household income, housing type, and presence of chronic illness were adjusted for in each model.

Propensity score matching (PSM) analysis was employed to minimize selection bias and avoid problems of endogeneity.[35] A propensity score was used to transform all matching variables to a conditional probability to balance the covariate between arts engagement and the control group to approach a random distribution and reduce the impact of covariates on the results.[36] Using a logistic regression model, a propensity score was determined for active arts engagement and non-active arts engagement groups, and passive arts engagement and non-passive arts engagement groups within the study period (i.e., average treatment effect on the treated (ATT)). The covariates entered into the propensity score included demographic characteristics (age, sex, education, occupation, religion, income, house type) and physical activity variables (light-intensity, moderate-intensity, vigorous-intensity, strength and balance, and all physical activities). Covariates selection in the propensity model was based on the criterion suggested by Brookhart et al.[37] To reduce bias, all meaningful covariates (associated to both exposure and outcomes, or to outcomes only) were decided a priori to get the optimized propensity score model.[38] The active and passive groups were matched with the control group on the logit of the propensity score, using calipers of width equal to 0.2 of the standard deviation.[39] A nearest neighbor matching technique without replacement was carried out using the Stata 'psmatch2' module.[40] The ability of the model to balance the cohorts was assessed using standardized differences. Successful matching was indicated when the absolute standardized mean difference before and after matching was less than 0.25.[41] A matching ratio of 1:2 was used for active arts engagement (to get more appropriate comparators as the proportion of active arts engagement was smaller) and 1:1 was used for passive arts engagement. All subsequent analyses were performed with the matched samples using methods appropriate for the analysis of matched data in estimating the impact of active or passive art as well as the statistical

significance. Independent t-tests were used to assess the impact of active or passive art on wellbeing on participants. Model sensitivity was tested using the Rosenbaum Bounds for Hodges-Lehmann Point Estimate to assess how robust the findings were to hidden bias due to unobserved covariates. The maximum Gamma (the odds of differential assignment to treatment due to unobserved factors) was set to two with increments of 0.1 to test at which point the between group differences were no longer robust.[42] All statistical analyses were performed by Stata version 14.2 for Windows (StataCorp, Texas, USA). A two-sided p-value less than 0.05 was considered as statistically significant.

RESULTS

Study participants' age ranged from 50 – 95 years (M=64.2, SD=10.0), with 45% males and 81% of Chinese ethnicity, of which were representative of Singapore's older population. 60% of participants reported attending at least one arts and culture activity within a time frame of six months (i.e. passive arts engagements), while 17% of the respondents reported actively participating in at least one arts and culture event within a timeframe of three months (i.e. active arts engagements). Overall, participants spent a median time of 6 hours attending arts events (IQR=11.0; range=0–258 hours) within a six-month time period, and a median time of 11 hours actively engaged in the arts (IQR=27.6; range=0–1015 hours) within a three-month time period. Top reported art forms among passive arts attendees in this sample included film (28%), heritage-related events (23%) and theatre (25%). As for active arts participants, engagements in visual arts (5%), music (4%) and craftwork (4%) were commonly reported. Detailed demographic information, physical activity levels and scores of all outcome variables are reported in table 1. For subsequent analysis, four outliers were identified and removed due to overtly high arts engagement hours (who may be professional artists or art enthusiasts), hence data from 1,063 participants were used for subsequent analyses. There were no missing data for the variables in this study.

Results from the correlational analyses indicated that passive arts engagement was associated with better wellbeing measures, specifically, quality of life (r=0.233, p<0.0001), perceived health (r=0.174, p<0.0001), social functioning (r=0.106, p = 0.001), mental health (r=0.124, p<0.0001), spiritual wellbeing (r=0.162, p<0.0001) and interpersonal support (r=0.172, p<0.0001). Furthermore, active engagements in the arts were associated with better quality of life (r=0.177, p<0.0001), health perceptions (r=0.130, p<0.0001), role functioning (r=0.078, p=0.011), social functioning (r=0.100, p=0.001) and mental health (r=0.154, p<0.0001), as well as enhanced spiritual wellbeing (r=0.201, p<0.0001) and interpersonal support (r=0.116, p<0.0001). After adjusting for covariates in each model, findings from exploratory regression analyses indicated that passive engagement in the arts was a significant independent predictor of better quality of life (β=0.166, SE=0.008, p<0.0001), health perceptions (β=0.146, SE=0.035, p<0.0001), mental health (β=0.095, SE=0.028, p=0.002), spiritual wellbeing (β=0.128, SE=0.014, p<0.0001) and interpersonal support (β=0.101, SE=0.012, p=0.0003). Similarly, active engagement in the arts were also a significant predictor of quality of life (β=0.139, SE=0.006, p<0.0001), health perceptions (β=0.078, SE=0.026 p=0.006) and spiritual wellbeing (β=0.065, SE=0.011, p=0.023). Please refer to table 2 for more details regarding the exploratory correlational and regression analyses.

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Table 1. Characteristics of Respondents

Demographic Characteristic	N (%)	Variable Information	N (%) / Mean (SD)
Demographic Background		**Arts Engagement Frequency (n, %)**	
Gender		Active Arts Engagement	178 (16.7)
Male	479 (44.9)	Top reported: Visual Art	49 (4.6)
Female	588 (55.1)	Top reported: Music	43 (4.0)
Age at time of survey (years)		Top reported:Craftwork	41 (3.8)
50 - 59	421 (39.5)	Passive Arts Engagement	645 (60.4)
60 - 69	372 (34.9)	Top reported: Film	295 (27.6)
>70	274 (25.7)	Top reported: Theatre	270 (25.3)
Marital Status		Top reported: Heritage-related events	244 (22.9)
Single/Divorced/Widowed	216 (20.2)	**Physical Activity Levels (Mean, SD)**	
Married	851 (79.8)	Light Intensity (Range: 0–57)	5.3 (9.3)
Ethnicity		Moderate Intensity (Range: 0–60)	2.0 (6.1)
Chinese	859 (80.5)	Vigorous Intensity (Range: 0–10)	0.3 (1.0)
Malay	121 (11.3)	Strength and Balance (Range: 0–30)	0.7 (1.5)
Indian	78 (7.3)	Overall Physical Activity (Range: 0–87)	8.2 (12.4)
Others (E.g. Eurasian)	9 (0.8)	**Wellbeing Variables (Mean, SD)**	
Highest Obtained Education		Quality of Life (WHOQOL-8)[b] (Range: 11–40)	31.4 (4.2)
Up to Primary/Elementary School	678 (63.5)	SF20[c] - Health Perception (Range: 0–100)	69.9 (19.6)
Secondary/High School or Above	389 (36.5)	SF20 - Pain (Range: 0–80)	17.4 (20.0)
Employment Status		SF20 - Social Functioning (Range: 0–100)	90.8 (21.4)
Full-time / Self-employed	309 (29.0)	SF20 - Role Functioning (Range: 0–100)	87.9 (29.3)
Part-time employed	148 (13.9)	SF20 - Physical Functioning (Range: 0–100)	86.1 (23.0)
Unemployed or Retired	610 (57.2)	SF20 - Mental Health (Range: 0–100)	81.9 (14.7)
Monthly Household Income (SGD)[a]		Interpersonal Support (ISEL-S)[d] (Range: 12–48)	37.8 (6.6)
< 2,000	412 (38.6)	Appraisal Support Subscale (Range: 4–16)	12.7 (2.4)
2,000 - 3,999	335 (31.4)	Belonging Support Subscale (Range: 4–16)	12.3 (2.6)
≥ 4,000	320 (30.0)	Tangible Support Subscale (Range: 4–16)	12.9 (2.3)
Housing Type		Spiritual Wellbeing (FACIT-Sp-12)[e] (Range: 7–48)	34.0 (8.0)
1 / 2 / 3-room flat	308 (28.9)	Meaning Subscale (Range: 1–16)	12.4 (2.9)
4-room flat	378 (35.4)	Peace Subscale (Range: 2–16)	12.3 (2.8)
5-room/ 3-Gen/ Executive/ Mansionette	277 (26.0)	Faith Subscale (Range: 0–16)	9.3 (3.8)
Condominium and Others	104 (9.7)		
Living Arrangements			
Family (e.g. Spouse, Children, Siblings)	968 (90.7)		
Living alone	71 (6.7)		
Others (e.g. Friends, Tenants)	28 (2.6)		

[a] SGD: Singapore Dollar, [b]WHOQOL-8: World Health Organization Quality of Life Instrument (8-item) , [c] SF20: 20-Item Short Form Survey, [d] ISEL-S: Interpersonal Support Evaluation List – Short Form; [e] FACIT-Sp-12: Functional Assessment of Chronic Illness Therapy - Spiritual Well-Being; The 12-item Spiritual Well-Being Scale

Table 2. Spearman Correlations and Multiple Regression Analyses Predicting Wellbeing

Wellbeing Measures	Passive Arts Engagement						Active Arts Engagement					
	Spearman Correlation		Multiple Regression				Spearman Correlation		Multiple Regression			
	r	p value	β	SE	p value	Adj. R^2	r	p value	β	SE	p value	Adj. R^2
Quality of Life (WHOQOL-8)	0.233	<0.0001*	0.166	0.008	<0.0001*	0.150	0.177	<0.0001*	0.139	0.006	<0.0001*	0.142
Holistic Health (SF20)												
SF20 - Health Perception	0.174	<0.0001*	0.146	0.035	<0.0001*	0.179	0.130	<0.0001*	0.078	0.026	0.006*	0.163
SF20 - Role Functioning	0.050	0.101	…	…	…	…	0.078	0.011*	…	…	…	…
SF20 - Pain Domain	-0.010	0.750	…	…	…	…	-0.024	0.430	…	…	…	…
SF20 - Social Functioning	0.106	0.0001*	…	…	…	…	0.100	0.0001*	…	…	…	…
SF20 - Physical Function	0.050	0.103	…	…	…	…	0.027	0.373	…	…	…	…
SF20 - Mental Health	0.124	<0.0001*	0.095	0.028	0.002*	0.069	0.154	<0.0001*	0.057	0.021	0.058	0.063
Spiritual Wellbeing (FACIT-SP-12)	0.162	<0.0001*	0.128	0.014	<0.0001*	0.177	0.201	<0.0001*	0.065	0.011	0.023*	0.164
Meaning Subscale	0.164	<0.0001*	0.121	0.005	<0.0001*	0.191	0.244	<0.0001*	0.081	0.004	0.004*	0.183
Peace Subscale	0.153	<0.0001*	0.123	0.005	<0.0001*	0.144	0.205	<0.0001*	0.094	0.004	0.001*	0.138
Faith Subscale	0.096	0.002*	0.084	0.007	0.003*	0.171	0.095	0.002*	0.004	0.005	0.896	0.164
Interpersonal Support (ISEL-S)	0.172	<0.0001*	0.101	0.012	0.0003*	0.180	0.116	<0.0001*	0.036	0.009	0.205	0.172
Appraisal Subscale	0.126	<0.0001*	0.086	0.004	0.003*	0.133	0.096	0.002*	0.030	0.003	0.299	0.127
Belonging Subscale	0.190	<0.0001*	0.123	0.005	<0.0001*	0.163	0.117	<0.0001*	0.043	0.003	0.134	0.150
Tangible Subscale	0.135	<0.0001*	0.059	0.004	0.039*	0.144	0.106	0.001*	0.022	0.003	0.439	0.141

*N= 1063, *p<0.05, Note: Variables which satisfied the normality tests are reported in the table; Covariates entered: age, gender, marital status, number of children, education, presence of religious belief, employment status, monthly household income, housing type, presence of chronic illness*

Balancing information before and after propensity score matching is presented in the table 3. After matching, a total of 444 (treatment = 176 & control = 268) cohort participants were included in the analysis for active group and 730 (treatment = 365 & control = 365) were included in the analysis for passive group respectively. All included covariates achieved balance after matching in the PSM analysis except for age and some physical activity components, however these differences were minimal. For the active engagement group, the median bias prior to matching was 22.8% and that was reduced to 1.4% after matching. The median bias prior to matching for the passive engagement group was 15.1% and was reduced to 8.6% after matching. The unmatched units were dropped as the propensity score model did not find any appropriate control with respect to the case. The characteristics of matching variables between matched and unmatched samples in both active and passive engagement groups were further compared. Descriptive analysis showed that propensity score model clearly distinguished the samples with similar characteristics in matched group compared with the unmatched group (see supplementary Table S1).

Detailed findings of the t-tests conducted are presented in table 4. Results from independent-samples t-tests revealed that participants who engaged in the arts scored significantly better in multiple measures of wellbeing. For the passive engagement group, participants reported a significantly higher quality of life [t(728)=3.35, p=0.0008, d=0.25] and perceived health scores [t(728)=2.21, p=0.0277, d=0.16] than matched controls. Although there were no significant differences in overall social wellbeing, arts attendees reported an enhanced sense of belonging [t(728)=2.17, p=0.03, d=0.16] in the social wellbeing subscale than non-arts attendees. Independent-sample t-tests conducted with the active arts engagement group also revealed significant mean differences in quality of life [t(442)=3.68, p=0.0003, d=0.36], perceived health [t(442)=2.59, p=0.0099, d=0.25] and overall spiritual wellbeing [t(442)=3.75, p=0.0002, d=0.37]. Moreover, participants who actively participated in the arts also reported greater spiritual wellbeing subscale scores in meaning in life [t(442)=5.02, p<0.0001, d=0.50] as well as sense of peace [t(442)=3.72, p=0.0002, d=0.36] in comparison to matched controls. Finally, although marginally significant, active arts participants also reported better social functioning [t(442)=1.68, p=0.0939, d=0.17] and mental health [t(442)=1.84, p=0.0668, d=0.18]. Model sensitivity analysis showed these results were acceptable and robust as Gamma value did not include zero in the lower and upper bounds when it increased to two.

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Table 3. Distribution of Balance for Covariates Before and After Matching by Propensity Score Matching (PSM) in Passive and Active Engagement Groups

Balance variables	Passive Engagement						Active Engagement					
	Before matching (n = 1063)			After matching (n = 730)			Before matching (n = 1063)			After matching (n = 444)		
	Passive Group (n = 642)	Non- Passive Group (n = 421)	Unstandardized mean difference	Passive Group (n = 365)	Non-Passive Group (n = 365)	Standardized mean difference	Active Group (n = 176)	Non-Active Group (n =887)	Unstandardized Mean difference	Active Group (n = 176)	Non-Active Group (n =268)	Standardized mean difference
Age (years)	62.57	66.73	-4.15	66.47	65.02	1.46	61.60	64.74	-3.14	61.60	61.09	0.51
Sex												
Male respondents	0.42	0.49	-0.07	0.52	0.47	0.05	0.38	0.46	-0.09	0.38	0.36	0.01
Marital Status												
Married	0.81	0.77	0.04	0.77	0.79	-0.02	0.86	0.79	0.07	0.86	0.86	0.00
Highest Obtained Education												
Elementary school	0.49	0.56	-0.07	0.64	0.58	0.06	0.43	0.54	-0.11	0.43	0.43	-0.01
High School or Higher	0.43	0.27	0.15	0.23	0.31	-0.08	0.53	0.33	0.20	0.53	0.52	0.01
Ethnicity												
Chinese ethnic group	0.81	0.79	0.02	0.78	0.80	-0.02	0.84	0.80	0.04	0.84	0.86	-0.03
Religious Belief												
Have religious belief	0.88	0.86	0.02	0.86	0.86	-0.01	0.88	0.87	0.01	0.88	0.88	0.00
Employment Status												
Part-time employed	0.16	0.11	0.05	0.10	0.13	-0.03	0.20	0.13	0.08	0.20	0.19	0.02
Full-time or self-employed	0.32	0.25	0.07	0.25	0.27	-0.02	0.32	0.29	0.03	0.32	0.32	0.00
Monthly Household Income (SGD)												
1,000 - 2,999	0.29	0.32	-0.03	0.36	0.32	0.04	0.24	0.31	-0.08	0.24	0.24	0.00
>3,000	0.51	0.39	0.13	0.37	0.42	-0.05	0.54	0.45	0.09	0.54	0.53	0.01
Housing Type												
3-4 room HDB Flat	0.55	0.62	-0.06	0.65	0.62	0.03	0.47	0.60	-0.13	0.47	0.46	0.01
5 room HDB Flat and others	0.38	0.31	0.07	0.28	0.32	-0.04	0.49	0.33	0.17	0.49	0.50	0.00
Physical Activity Levels (Hours)												
Light Intensity	6.49	3.43	3.06	2.52	3.69	-1.17	9.09	4.52	4.57	9.09	8.97	0.13
Moderate Intensity	2.46	1.42	1.04	1.02	1.59	-0.56	3.30	1.80	1.50	3.30	3.33	-0.03
Vigorous Intensity	0.03	0.16	-0.13	0.11	0.16	-0.05	0.51	0.20	0.31	0.51	0.53	-0.02
Strength and Balance	0.78	0.51	0.26	0.46	0.56	-0.11	1.00	0.61	0.39	1.00	0.84	0.16
All Physical Activities	10.05	5.52	4.52	4.11	6.01	-1.90	13.91	7.13	6.78	13.91	13.68	0.23

Table 4. Group Differences in Wellbeing Scores

Wellbeing	Passive Arts Engagement[a]					Active Arts Engagement[b]				
	Passive (Mean ± SD)	Control (Mean ± SD)	t(728)	p	Effect Size(d)	Active (Mean ± SD)	Control (Mean ± SD)	t(442)	p	Effect Size(d)
Quality of Life (WHOQOL-8)	31.5 ± 4.15	30.5 ± 4.2	3.35	0.0008*	0.25	33.0 ± 4.16	31.5 ± 4.14	3.68	0.0003*	0.36
Short Form Health Survey (SF-20)										
SF20 - Health Perception	69.6 ± 19.9	66.3 ± 21.1	2.21	0.028*	0.16	75.5 ± 18.2	70.7 ± 19.3	2.59	0.0099*	0.25
SF20 - Role Functioning	85.4 ± 31.2	86.4 ± 31.7	0.44	0.659	0.03	92.8 ± 24.2	91.1 ± 26.1	0.66	0.512	0.06
SF20 - Pain Domain	18.1 ± 20.9	17.8 ± 20.7	0.18	0.859	0.01	16.7 ± 20.6	17.9 ± 19.6	0.62	0.538	0.06
SF20 - Social Functioning	90.9 ± 19.6	88.9 ± 24.5	1.20	0.230	0.09	95.6 ± 14.7	92.8 ± 18.7	1.68	0.094	0.17
SF20 - Physical Function	84.9 ± 22.2	84.4 ± 25.2	0.27	0.785	0.02	89.2 ± 18.6	88.5 ± 20.9	0.37	0.715	0.04
SF20 - Mental Health	81.2 ± 14.8	80.5 ± 15.4	0.63	0.532	0.05	86.0 ± 13.1	83.6 ± 14.0	1.84	0.067	0.18
Interpersonal Support (ISEL-S)	37.4 ± 6.3	36.8 ± 6.4	1.14	0.253	0.08	39.4 ± 6.9	38.7 ± 6.4	1.10	0.273	0.11
Appraisal Subscale	12.4 ± 2.3	12.4 ± 2.4	0.32	0.751	0.02	13.1 ± 2.6	12.9 ± 2.4	0.70	0.483	0.07
Belonging Subscale	12.2 ± 2.5	11.8 ± 2.6	2.17	0.030*	0.16	12.9 ± 2.6	12.6 ± 2.4	1.16	0.246	0.11
Tangible Subscale	12.7 ± 2.2	12.6 ± 2.3	0.44	0.658	0.03	13.4 ± 2.5	13.1 ± 2.2	1.12	0.262	0.11
Spiritual Wellbeing (FACIT-Sp-12)	33.5 ± 8.0	33.1 ± 8.1	0.68	0.496	0.05	37.5 ± 7.2	34.7 ± 7.7	3.75	0.0002*	0.37
Meaning Subscale	12.2 ± 2.8	12.1 ± 3.0	0.12	0.908	0.01	13.9 ± 2.3	12.6 ± 2.8	5.03	<0.0001*	0.50
Peace Subscale	12.1 ± 2.7	11.9 ± 3.0	0.81	0.419	0.06	13.5 ± 2.6	12.5 ± 2.7	3.72	0.0002*	0.36
Faith Subscale	9.3 ± 3.9	9.0 ± 3.9	0.73	0.464	0.05	10.1 ± 4.0	9.6 ± 3.8	1.25	0.211	0.12

[a]n = 730, [b]n = 444; *p<0.05

DISCUSSION

This was the first-ever empirical research that examined arts engagements and its impact on holistic wellbeing among current and future elderly populations in Asia using naturalistic observational data with PSM analysis. This study established significantly strong causal relationships between arts engagements (both passive and active engagements) and numerous domains of holistic wellbeing in a naturalistic sample of older adults in Singapore. The results revealed that by passively engaging in the arts, older adults experienced significantly higher quality of life, better perceived health and greater social connectedness as compared to non-art attendees. The results further showed that older adults who actively engaged in the arts experienced significantly enhanced quality of life, better perceived health, stronger spiritual wellness, life meaning and peace with a medium effect size, as compared to non-art participants. These findings support that varying depths of arts engagements could impact different domains of holistic wellness among older adults, where both passive exposures to and active engagements in the arts could bring about quality of life and subjective health benefits.

The findings from this study also supported past literature, [43-45] and provided novel contributions to the growing research on arts, health and wellness. Firstly, the present study adopted a holistic view and assessed multiple domains of wellbeing including quality of life, perceived health and mental health, social support and spiritual wellness, whereas past studies only examined the effects of the arts on one or a very selected few facets of wellbeing.[10,11,43-45] Secondly, the present study included an extensive range of art forms with specific cultural genres (e.g. 'angklung' - bamboo flute, 'wayang kulit' – shadow puppets, and Chinese operas) to investigate its effects on health and wellness among a specific cohort of current and soon-to-be older adults between the ages of 50 and 95, as well as employed a stratified random survey method to recruit a sizable sample that was highly representative of Singapore's elderly population. Thus, the results generated had strong generalizability to local populations and provided policy makers, practitioners and researchers with age and cultural-specific insights on programme development.[46] The results could also serve as a frame of reference for the advancement of other Asian societies that share similar socio-cultural demographics and structures such as Hong Kong, Malaysia and other major cities in China. Finally, through propensity score matching, participants engaged in the arts were systematically matched on multiple covariates with respondents who did not engage in the arts. This allowed for meaningful comparisons between groups in a naturalistic sample, of which is greatly lacking in the literature on arts, health and wellness. To our knowledge, this is the first arts and health study that employed this analytical method.

One can connect to literature on creativity, self-mastery, relational aesthetics and neurological sciences for the inner workings of arts and wellness. Arts engagement fosters an empowering process of creativity and autonomy that cultivates mindful-awareness, self-understanding and new insights.[47] This in turn facilitates motivation for narrative identity processing,[48] a constructive reflection process of character building that fosters life meaning and self-affirmation, leading to the development of self-mastery.[49,50] Through arts engagements, individuals would also encounter relational aesthetics, an experience of emotional connections via metaphoric dialogue with the arts and the artists that broadens perspectives and nurtures diversity, while inspiring human connections, empathy and compassionate citizenry.[51,52] Arts engagement may also have a role to play in stimulating the parasympathetic nervous system, leading to a greater sense of peace and relaxation.[53] Finally, neurological literature has illustrated the effects of arts as a means for stimulating

neuroplasticity and building cognitive reserve.[54,55] As such, it is evident that the arts can positively impact various domains of wellbeing through numerous psychosocial processes, particularly for older adults whose sense of identity and personhood progressively decline with the onset of old age, worsening health and diminishing social networks.[56]

Future arts-based elderly care programmes may target these avenues and pathways for wellness promotion. The findings show that attending art events could reap social and relational benefits for tackling social isolation, while creating art could harness intrinsic benefits that lead to spiritual fulfillment and growth. From a policy perspective, this translates into multiple entry points for attracting and maintaining arts participation among older populations. Thus, considerations for a formal and sustainable structure that incorporates participatory art initiatives and programmes into aged care services, while ensuring proficient training of more community art workers to support these works could be made as this would be a cost-effective way to promote healthy, creative and meaningful ageing. Despite the positive effects of creative arts engagement on health, it has been repeatedly found that promoting engagement in the arts among the elderly is difficult, as participation in the arts generally declines with age, most progressively among individuals reaching age of 65, and most markedly for those aged 75 and above.[57] Similar findings have also been reported in Singapore, where older adults aged 60 and above had the lowest art attendance and art participation rates among all age cohorts.[58] Within this sample, art participation rates among adults aged 50 and above was 17%. This trend is disconcerting given the fact that the arts could play a significant role in supporting well-being in old age. From a practice perspective, participatory arts programmes and initiatives could include public education and advocacy campaigns to promote arts engagements, art-based psychosocial care programming designed for community and residential care settings, as well as collaboration with arts and cultural heritage intuitions in developing arts programmes that are fitting to the needs and interests of older adults. Practitioners and health care providers could consider the arts as a non-medical, non-pharmaceutical agent for mental health and quality of life enhancement, and may also consider integrating passive art activities to enhance social programmes for older adults. Finally, the arts may also be considered as a gateway to support stronger social networks for tackling the public health problem of loneliness through programmes that use the arts as platforms for outreach, relational bonding and community building.

The results of this study, although theoretically and practically appealing, were not without its limitations. Firstly, potential confounders were balanced in the PSM except for age and frequency of light intensity physical activity, hence caution must be exercised when interpreting the results. Moreover, despite having model sensitivity analyses conducted for unobserved covariates, the presence of other potential confounding variables in this study such as the presence competing social activities, recreational and religious activities, as well as living arrangements should be assessed and controlled for in future research. Secondly, the arts engagement assessment items required the accuracy of memory recall (three to six months prior to data collection) from the participants and the psychometric measures were self-reported. Future research could consider administering objective measures of arts engagement such as clinical observations and activity journals, as well as functional magnetic resonance imaging (fMRI) and heart rate variability (HRV) to assess the objective health and wellbeing outcomes. Finally, the current study employed cross-sectional survey data that assessed participants at a single time point, and thus was not possible to rule out the potentiality of reverse

causality. For example, while our findings reveal that art attendance enhances one's sense of belonging, the opposite may hold true where a sense of belonging could be a precursor to art attendance, implying that programme design and implementation would need to target both enablers, namely to facilitate belonging and making art appealing. In order to obtain a deeper understanding of the causal and directional effects of arts engagement, future studies should consider implementing a robust experimental or longitudinal research design. Despite these limitations, the findings generated from this study are important starting points for future empirical research in Singapore and neighboring regions, as they provide a critical cross-cultural understanding on the relationship between arts and wellness in greater Asia, while contributing to the growing literature on the subject matter internationally.

In conclusion, the arts can play a significant role in sustaining a healthy, active and resilient elderly populace with greater cost-efficiency than traditional medicine and health service models. Under the rubric of rapid population ageing, the need for more evidence-driven arts promotion initiatives to foster active and creative ageing, as well as greater art-based psychosocial care for the elderly is urgently warranted in Asia and around the globe.

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AUTHOR CONTRIBUTIONS

COMPETING INTERESTS

ROLE OF THE FUNDING SOURCE

DATA AVAILABILITY STATEMENT

No additional data available.

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EXCLUSIVE LICENCE

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Table S1: Comparison of background variables between matched and unmatched samples in active and passive engagement groups

Variables	Active engagement			Passive engagement		
	Unmatched (n = 619)	Matched (n = 444)	P-value	Unmatched (n = 333)	Matched (n = 730)	P-value
Age (years)	66.4 ± 10.6	61.2 ± 8.3	<0.001	66.4 ± 11.1	63.2 ± 9.4	<0.001
Sex			<0.001			0.173
Male	308 (49.8)	170 (38.3)		160 (48.1)	318 (43.6)	
Female	311 (50.2)	274 (61.7)		173 (51.9)	412 (56.4)	
Marital Status			0.001			0.037
Single	147 (23.7)	68 (15.3)		80 (24.0)	135 (18.5)	
Married	472 (76.3)	376 (84.7)		253 (76.0)	595 (81.5)	
Educational status			<0.001			<0.001
No Formal Education	110 (17.8)	15 (3.4)		57 (17.1)	68 (9.3)	
Elementary school	341 (55.1)	210 (47.3)		176 (52.9)	375 (51.4)	
High school or Higher	168 (27.1)	219 (49.3)		100 (30.0)	287 (39.3)	
Ethnicity			0.010			0.758
Non-Chinese	137 (22.1)	70 (15.8)		63 (18.9)	144 (19.7)	
Chinese	482 (77.9)	374 (84.2)		270 (81.1)	586 (80.3)	
Religious belief			0.351			0.498
No religious belief	86 (13.9)	53 (11.9)		47 (14.1)	92 (12.6)	
Have a religious belief	533 (86.1)	391 (88.1)		286 (85.9)	638 (87.4)	
Employment status			<0.001			0.009
Unemployed/retired	388 (62.6)	219 (49.3)		213 (64.0)	394 (54.0)	
Part time employment	61 (9.9)	86 (19.4)		39 (11.7)	108 (14.8)	
Full time/ self-employed	170 (27.5)	139 (31.3)		81 (24.3)	228 (31.2)	
Monthly household income (SGD)			0.001			0.004
<1,000	164 (26.5)	86 (19.4)		96 (28.8)	154 (21.1)	
1,000 - 2,999	197 (31.8)	124 (27.9)		106 (31.8)	215 (29.5)	
>3,000	258 (41.7)	234 (52.7)		131 (39.4)	361 (49.4)	
Housing type			<0.001			0.099
1-2 room HDB flat	55 (8.9)	14 (3.2)		29 (8.7)	40 (5.5)	
3-4 room HDB flat	389 (62.8)	226 (50.9)		194 (58.3)	421 (57.7)	
5 room HDB flat and others	175 (28.3)	204 (45.9)		110 (33.0)	269 (36.8)	
Physical activity level (hours)						
Light intensity (mean ± s.d.)	4.1 ± 7.4	6.9 ± 11.3	0.0002	4.6 ± 9.4	5.6 ± 9.3	0.023
Moderate intensity (mean ± s.d.)	1.7 ± 5.7	2.5 ± 6.6	0.0001	1.6 ± 5.2	2.2 ± 6.5	0.005
Vigorous intensity (mean ± s.d.)	0.2 ± 0.8	0.3 ± 1.2	0.015	0.2 ± 0.9	0.3 ± 1.0	0.009
Strength and balance (mean ± s.d.)	0.6 ± 1.6	0.8 ± 1.4	0.010	0.6 ± 1.9	0.7 ± 1.3	0.105
All physical activity (mean ± s.d.)	6.6 ± 10.6	10.5 ± 14.4	<0.001	7.1 ± 12.1	8.8 ± 12.6	0.0002

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The Arts for Ageing Well: A Propensity Score Matching Analysis of the Effects of Arts Engagements on Holistic Wellbeing among Asian Elderly Population

STROBE Statement—Checklist of items that should be included in reports of *cross-sectional studies*

	Item No	Recommendation	Reported on Manuscript Page (Section)
Title and abstract	1	(*a*) Indicate the study's design with a commonly used term in the title or the abstract	1 (Title)
		(*b*) Provide in the abstract an informative and balanced summary of what was done and what was found	2 (Abstract)
Introduction			
Background/rationale	2	Explain the scientific background and rationale for the investigation being reported	3,4 (Introduction)
Objectives	3	State specific objectives, including any prespecified hypotheses	4 (Research Objectives)
Methods			
Study design	4	Present key elements of study design early in the paper	5 (Study Design and Participants)
Setting	5	Describe the setting, locations, and relevant dates, including periods of recruitment, exposure, follow-up, and data collection	5 (Study Design and Participants)
Participants	6	(*a*) Give the eligibility criteria, and the sources and methods of selection of participants	5 (Study Design and Participants)
Variables	7	Clearly define all outcomes, exposures, predictors, potential confounders, and effect modifiers. Give diagnostic criteria, if applicable	5 (Study variables)
Data sources/ measurement	8*	For each variable of interest, give sources of data and details of methods of assessment (measurement). Describe comparability of assessment methods if there is more than one group	6 (Study variables)
Bias	9	Describe any efforts to address potential sources of bias	7,8 (Statistical Analysis)
Study size	10	Explain how the study size was arrived at	4 (Study Design and Participants)
Quantitative variables	11	Explain how quantitative variables were handled in the analyses. If applicable, describe which groupings were chosen and why	7 (Statistical Analysis)
Statistical methods	12	(*a*) Describe all statistical methods, including those used to control for confounding	7,8 (Statistical Analysis)
		(*b*) Describe any methods used to examine subgroups and interactions	7,8 (Statistical Analysis)
		(*c*) Explain how missing data were addressed	8 (Results)
		(*d*) If applicable, describe analytical methods taking account of sampling strategy	5 (Study Design and Participants)
		(*e*) Describe any sensitivity analyses	8 (Methods) 10 (Results)

The Arts for Ageing Well: A Propensity Score Matching Analysis of the Effects of Arts Engagement on Holistic Wellbeing among Elderly Population in Asia

Results			
Participants	13*	(a) Report numbers of individuals at each stage of study—eg numbers potentially eligible, examined for eligibility, confirmed eligible, included in the study, completing follow-up, and analysed	5 (Methods; Procedures)
		(b) Give reasons for non-participation at each stage	5 (Methods; Procedures)
		(c) Consider use of a flow diagram	N.A.
Descriptive data	14*	(a) Give characteristics of study participants (eg demographic, clinical, social) and information on exposures and potential confounders	8 (Results), 9 (Table 1)
		(b) Indicate number of participants with missing data for each variable of interest	8 (Results)
Outcome data	15*	Report numbers of outcome events or summary measures	8 (Results), 9 (Table 1)
Main results	16	(*a*) Give unadjusted estimates and, if applicable, confounder-adjusted estimates and their precision (eg, 95% confidence interval). Make clear which confounders were adjusted for and why they were included	12 (Table 3)
		(*b*) Report category boundaries when continuous variables were categorized	N.A.
		(*c*) If relevant, consider translating estimates of relative risk into absolute risk for a meaningful time period	N.A.
Other analyses	17	Report other analyses done—eg analyses of subgroups and interactions, and sensitivity analyses	8 (Methods) 10 (Results)
Discussion			
Key results	18	Summarise key results with reference to study objectives	14 (Discussion)
Limitations	19	Discuss limitations of the study, taking into account sources of potential bias or imprecision. Discuss both direction and magnitude of any potential bias	15 (Discussion)
Interpretation	20	Give a cautious overall interpretation of results considering objectives, limitations, multiplicity of analyses, results from similar studies, and other relevant evidence	14, 15 (Discussion)
Generalizability	21	Discuss the generalizability (external validity) of the study results	14, 15 (Discussion)
Other information			
Funding	22	Give the source of funding and the role of the funders for the present study and, if applicable, for the original study on which the present article is based	16 (Role of the Funding Source)

*Give information separately for exposed and unexposed groups.

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Note: An Explanation and Elaboration article discusses each checklist item and gives methodological background and published examples of transparent reporting. The STROBE checklist is best used in conjunction with this article (freely available on the Web sites of PLoS Medicine at http://www.plosmedicine.org/, Annals of Internal Medicine at http://www.annals.org/, and Epidemiology at http://www.epidem.com/). Information on the STROBE Initiative is available at www.strobe-statement.org.

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The Arts for Ageing Well: A Propensity Score Matching Analysis of the Effects of Arts Engagements on Holistic Wellbeing among Older Asian Adults above 50 years of age

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The Arts for Ageing Well: A Propensity Score Matching Analysis of the Effects of Arts Engagements on Holistic Wellbeing among Older Asian Adults above 50 years of age

Andy Hau Yan Ho[1, 2*], Stephanie Hilary Xinyi Ma[1], Moon-Ho Ringo Ho[1], Joyce Shumin Pang[1], Emily Ortega[3], Ram Chandra Bajpai[2,4]

[1]Psychology Programme, School of Social Sciences, Nanyang Technological University, Singapore.

[2]Centre for Population Health Sciences, Lee Kong Chian School of Medicine, Nanyang Technological University, Singapore.

[3]Psychology Programme, School of Humanities and Behavioral Sciences, Singapore University of Social Sciences, Singapore.

[4]School of Primary, Community and Social Care, Keele University, Staffordshire, UK ST5 5BG

* Correspondence to: Dr Andy Hau Yan Ho, School of Social Sciences, 48 Nanyang Avenue, HSS-04-03, Singapore 639818. Email: andyhyho@ntu.edu.sg   Tel: +65 6316 8943

(Manuscript Word Count: 4,862)

Abstract

Objective: To assess the frequency and intensity of arts engagement inclusive of active and passive engagements in arts, culture and heritage activities among Singaporean adults aged 50 and above, and examine the relationships between participatory art and holistic wellbeing.

Design: Cross-sectional stratified household survey.

Setting: All residential areas across Singapore's Central, East, North, North-East and West Regions.

Participants: 1,067 community-dwelling, Singaporean older adults between the ages of 50-95 years were recruited.

Primary and secondary outcome measures: Respondents completed a self-reported questionnaire, consisting of standardized ad hoc items assessing the frequencies and durations of active and passive participatory arts engagement, as well as validated psychometric assessments on psycho-socio-spiritual health including the primary outcome measure on quality of life, and the secondary outcome measures on physical, psychological, emotional, spiritual, and social well-being. Socio-demographic information, as well as frequency and intensity of physical activity were also collected.

Results: Passive engagement (60%) and active engagement (17%) in the arts were associated with better holistic wellness and social support. Specifically, findings from the propensity score matching (PSM) and independent t-test analyses revealed that adults aged 50 and above who passively engaged in arts and culture-related events experienced higher quality of life [$t(728)=3.35$, $p=0.0008$, $d=0.25$], perceived health [$t(728)=2.21$, $p=0.0277$, $d=0.16$], and sense of belonging [$t(728)=2.17$, $p=0.03$, $d=0.16$], as compared to those who did not. Moreover, those who actively engaged in participatory arts experienced greater quality of life [$t(442)=3.68$, $p=0.0003$, $d=0.36$], self-rated health [$t(442)=2.59$, $p=0.0099$, $d=0.25$], spiritual wellbeing [$t(442)=3.75$, $p=0.0002$, $d=0.37$], meaning in life [$t(442)=5.02$, $p<0.0001$, $d=0.50$], and sense of peace [$t(442)=3.72$, $p=0.0002$, $d=0.36$], as compared to those who did not actively engaged in the arts.

Conclusion: This study provided robust evidence to support a significant causal relationship between arts engagements and holistic wellbeing. Recommendations for art-based public health and elderly care research, practice and policy are discussed.

Keywords: *Holistic wellbeing; Creative ageing; Participatory art; Propensity score matching; Public Health, Mental Health; Asia*

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STRENGTHS AND LIMITATIONS OF THIS STUDY

- First-ever empirical research to date that examined arts engagements and its impact on holistic wellbeing in Asia using naturalistic observational data.

- Sample was a large, representative older adult population in Singapore

- Propensity score matching (PSM) analysis was employed to minimize selection bias and avoid problems of endogeneity, allowing for comparisons between art-active groups and non-art-active groups.

- A wide range of art forms were assessed, of which included active engagements and passive consumption of eight art forms - music, dance, theatre, literary arts, visual arts, heritage activities, film, and craft events.

- The current study employed cross-sectional survey data that assessed participants at a single time point, and thus is not possible to rule out the potentiality of reverse causality.

INTRODUCTION

Asia is ageing at a much faster rate than anywhere else in the world.[1] In Singapore specifically, the proportion of adults aged 65 and above has more than doubled in the past two decades from 6% in 1990 to 13% in 2017. This trend will exponentially increase to approximately 25% by 2030.[2] Longevity, however, does not necessarily reflect better health at old age. According to recent statistics, 60% of Singaporeans aged 50 and above suffered from a chronic illness such as diabetes, heart disease and stroke, while 10% of adults aged 60 and above, as well as 50% of adults aged 85 and above were affected by dementia.[3, 4] Additionally, 51% of Singaporeans above the age of 60 reported feelings of loneliness and were at a greater risk of mortality.[5] These numbers reflect greater demands for health and social care services among the aged in the foreseeable future.

While traditional biomedical models have focused predominantly on supporting elderly health through curative interventions and rehabilitation services, contemporary public health approaches emphasize a health-promoting paradigm for maintaining and elevating holistic wellbeing, through cultivating personal autonomy, social participation and community involvement.[6] One has to look no further than to the Arts to realize its vital significance in cultivating these goals, as engagements in the cultural heritage of music, dance, theatre, literature as well as the visual arts have been known to have tangible effects on health and quality of life, whereby the agents of creativity and imagination can help "keep individual resilience, aid recovery and foster a flourishing society" (p.3).[7] Despite the extensive use of the arts for its therapeutic properties across history, research investigating healthy and active ageing through arts engagement were fairly recent.[8]

To consolidate existing research that investigated the relationship between arts engagement, health wellbeing and ageing, a literature search was conducted through PsycInfo, Web of Science, Social Science Citation Index, PubMed, and Medline. Relevant reports and studies published by governments and related organizations were also examined. Overall, the research team found robust evidence to support the efficacy of the arts in promoting wellness. Most notably, the Creative Health inquiry report published in the United Kingdom, which examined over 1,000 peer-reviewed and grey literature, concluded that not only can the arts bring various health and mental health benefits to people of all ages, it can also serve to address health and social care challenges in greater society such as ageing, longer-term conditions and loneliness.[9] Among studies that focused on community dwelling older adults, multiple reviews of empirical research that studied the

relationships between art-based interventions and healthy ageing revealed that active engagements in various forms of art produced positive cognitive, affective, and quality of life outcomes.[10,11] For instance, a randomized controlled trial on participatory singing activities reported its effectiveness in enhancing quality of life, and reducing anxiety and depression among older intervention participants. [12] Moreover, the Museums on Prescription Study showed that cultural heritage engagements were effective in improving psychological and social wellbeing.[13,14] Moreover, the efficacy of the arts in the treatment of mental health conditions, as well as support for the treatment of various chronic health conditions were well documented.[15,16] Numerous systematic reviews also suggested that various forms of participatory art activities were beneficial for persons with dementia living in residential care settings, serving to enhance cognitive processes, attention, mood and memory.[17, 18] Specifically, musical activities yielded better episodic memory and mood among patients with early dementia in a recent randomized controlled trial.[19] Finally, although limited, art and cultural heritage-based intervention studies with Asian populations have also shown similar positive results in psychological wellbeing.[20]

Despite robust evidence on the benefits of art-based interventions applied in the abovementioned settings, much less research has examined the impact of arts engagements in naturalistic settings.[21] In fact, many studies employed simple pre-and-post intervention designs without control groups, while others employed relatively small sample sizes that prevented meaningful comparisons.[11] Often, participants of these studies were recruited via convenience sampling rather than random sampling, potentially resulting in response biases.[15] With a rapidly ageing population around the globe and in Asia, there is a need to understand the landscape of arts engagement and to investigate the relationships between arts engagement and holistic well-being for advancing practices and policies that promote healthy and creative ageing. The "Arts for Ageing Well" study was the first-ever attempt to critically address this important knowledge gap by utilizing a holistic investigative approach with both quantitative and qualitative methodologies for exploring and understanding the notion of ageing well with the arts in Asia. This article reports the quantitative findings of the Arts for Ageing Well study.

Research Objectives

The specific objectives of this study were to (i) assess the frequency and intensity of arts engagement inclusive of active and passive engagements in music, dance, theatre, literary arts, visual arts, film, heritage events and activities, and craft events among Singaporean adults aged 50 and above, and to (ii) examine the relationships between participatory art and holistic well-being in terms quality of life, physical, psychological, emotional, spiritual, and social well-being.

METHODS

Study Design and Participants

1,067 participants were recruited between July 2016 and February 2017 across all regions of Singapore via a cross-sectional stratified random household survey to ensure sample representativeness of the national population. Sample size calculation was based on power analysis; a sample size of 1,067 allowed for ± 3% accuracy at the 95% confidence level. A sampling frame comprising all residential dwelling units with at least one resident aged 50 and above, spanning across all geographical areas demarcated by the Urban

Redevelopment Authority as residential areas that covered Singapore's Central, East, North, North-East and West Regions, was obtained from the Singapore Department of Statistics. Dwelling units were grouped into four non-overlapping strata according to age group, and were further stratified into gender, ethnicity, and housing types. Based on the resulting Master List, a fixed number of dwelling units were selected by a systematic sampling procedure with a random start. The inclusion criteria were community dwelling Singapore residents, who were able to communicate in either English, Malay, Mandarin, Tamil, Hokkien or Cantonese. The exclusion criteria were individuals who were visibly too ill or frail to participate or were unable to provide informed consent due to cognitive impairment as assessed by a screening question during recruitment and continuous observation throughout a face-to-face survey interview.

Procedures

Potential participants were selected from the master list in a sequential order and were contacted in-person through door-to-door home visits across Singapore. A minimum of three attempts were made to contact participants, before moving to the next participant in the master list. Upon initial contact, successfully engaged participants were informed of the study's background, rationale and details of their participation. Only one adult above the age of 50 was recruited from each randomly selected household. After informed consent, participants completed a standardized survey on arts engagement and holistic wellbeing via a 30 to 45-minute structured face-to-face interview. Each survey was conducted at the home of the participant, and each participant received a cash voucher of SGD$20 upon completion of the survey. The response rate for this study was 59%. 1,797 households with current or soon-to-be older adults were contacted to participate in the study; 68 interested individuals (4%) did not meet the inclusion criteria, 662 potentially eligible participants (37%) declined to participate in the study or dropped out, 1,067 (59%) eligible and consenting participants were recruited and completed the survey.

Ethical considerations

Ethical approval was obtained through Nanyang Technological University's Institutional Review Board before study commencement (IRB-2016-05-027). All participants were briefed and interviewed by trained interviewers who received regular supervision. Individual written consent was obtained prior to data collection.

Patient and Public Involvement

Research participants were not involved in the development of the research question, design, recruitment processes and conduct of the study. The findings of the study were disseminated locally via press coverage, and media interviews and conference presentations.

Study variables

Arts Engagement

A series of standardized ad hoc items were developed to assess the frequency and duration of arts engagement among study participants, of which included active engagements and passive consumption of eight specific art forms – music, dance, theatre, literary arts, visual arts, heritage activities, film and handicraft.[22]

Arts engagement was measured in terms of active engagement and passive engagement. Active engagement was construed as the active participation in art, heritage and cultural activities such as creating, while passive engagement referred to passive behaviors such as attending, viewing or listening.[23] Some examples of engagement in the study included attendance or participation in theatre events (e.g. attending musicals, performance in traditional theatre), music activities (e.g. listening to classical music, playing a musical instrument), dance performances (e.g. watching a ballet performance, participating in line dancing classes), visual arts activities (e.g. visiting art fairs, doing photography), heritage-related activities (e.g. visiting heritage buildings and monuments, providing guided cultural tours to others), literary arts-related events (e.g. attending a book launch, writing biographies), film-related events (e.g. attending a film festival, participating in a local film production) and craft activities (e.g. watching a handicraft demonstration, teaching embroidery classes). Participants were asked to recount their active engagements over the past three months and passive engagements over the past six months since the time of survey to facilitate accurate recall and comprehensive recording of all art activities. This difference in timeframe in assessing passive and active art engagement was due to the nature of engagement; existing research has shown that the frequency and duration for passive arts engagement were typically much sparser than active arts engagement,[24] and therefore a longer recall timeframe served to capture sufficient data for analysis. Overall scores of the total hours of active and passive arts engagement were calculated for each participant.

Covariates

To better understand the potential interplay between arts engagement and physical activity on well-being, a series of standardized items based on Singapore's National Physical Activities Guidelines,[25] was developed to assess the frequency and intensity of physical activity engagement among study participants. These items reflect light-intensity lifestyle activities such as walking, moderate-intensity physical activities (e.g. low-impact aerobics), vigorous-intensity physical activity (e.g. jogging), and strength and balance activities (e.g. Tai Chi). To determine whether medical and demographic variables were potential confounding factors, participant's clinical health information were assessed via self-reported presence of chronic illness and time since diagnosis. Demographic data including age, gender, marital status, family composition, socio-economic status and religion were also collected.

Outcome variables

Outcome variables measured and reported in the current study included quality of life and holistic wellbeing inclusive of the physical, mental, spiritual, and social domains. Quality of life was assessed using the 8-item World Health Organization Quality of Life Instrument (WHOQoL-8).[26] The WHOQoL-8 is a highly reliable 8-item scale ($\alpha = 0.86$) that measured participants' perceived quality of life domains including health, energy for everyday life, ability to perform daily activities, satisfaction with self, satisfaction with relationships, personal finances, living conditions and overall quality of life. Scores ranged from 8 – 40, with higher values representing better quality of life. Physical and mental wellbeing were assessed using the Short Form 20 (SF-20) Health Survey.[27] The SF-20 comprised of 20 items that measured six health domains including the subscales of health perceptions, physical role functioning, presence of bodily pain, perceived social functioning, physical functioning and mental health. Item scores were transformed individually and linearly, and were averaged for

final domain scores used for analyses. Higher values represented better self-reported health for all subscales, except for the bodily pain subscale, where higher values represented more reported bodily pain. Spiritual wellbeing was assessed using the 12-item Functional Assessment of Chronic Illness Therapy - Spiritual Wellbeing (FACIT-SP-12). The FACIT-SP-12 is a reliable scale ($\alpha = 0.87$) which measured the three domains of meaning, peace and faith.[28] Possible scores ranged from $0 – 48$, with higher scores indicating better spiritual wellbeing. Social wellbeing was assessed using the Interpersonal Support Evaluation List Short Form (ISEL-S).[29] The 12-item ISEL-S is a highly reliable scale ($\alpha = 0.90$) which measured the three domains of appraisal support, belonging support and tangible support. Overall scores were calculated for the analyses, with higher scores representing better social wellbeing. As Singapore is a multi-lingual society, the questionnaire was prepared in English, Malay, Chinese and Tamil. The Chinese versions of the WHOQOL-8, ISEL-S, SF20 and FACIT-SP scales, as well as the Malay version of the WHOQOL-8 were adapted from past studies with Asian older adults.[30-34] The other scales were translated to Malay and Tamil by a professional translator, back-translated, pilot tested and verified by the research team.

Statistical Analysis

Descriptive analyses were performed on all demographic, arts engagement, physical activity and outcome variables. Bivariate correlations and exploratory multiple linear regression analyses were conducted to understand the association between passive and active arts engagement, and various factors of holistic wellbeing. Socio-demographic variables including age, gender, marital status, number of children, highest education achieved, employment status, household income, housing type, and presence of chronic illness were adjusted for in each model.

Propensity score matching (PSM) analysis was employed to minimize selection bias and avoid problems of endogeneity.[35] A propensity score was used to transform all matching variables to a conditional probability to balance the covariate between arts engagement and the control group to approach a random distribution and reduce the impact of covariates on the results.[36] Using a logistic regression model, a propensity score was determined for active arts engagement and non-active arts engagement groups, and passive arts engagement and non-passive arts engagement groups within the study period (i.e., average treatment effect on the treated (ATT)). The covariates entered into the propensity score included demographic characteristics (age, sex, education, occupation, religion, income, house type) and physical activity variables (light-intensity, moderate-intensity, vigorous-intensity, strength and balance, and all physical activities). Covariates selection in the propensity model was based on the criterion suggested by Brookhart et al.[37] To reduce bias, all meaningful covariates (associated to both exposure and outcomes, or to outcomes only) were decided a priori to get the optimized propensity score model.[38] The active and passive groups were matched with the control group on the logit of the propensity score, using calipers of width equal to 0.2 of the standard deviation.[39] A nearest neighbor matching technique without replacement was carried out using the Stata 'psmatch2' module.[40] The ability of the model to balance the cohorts was assessed using standardized differences. Successful matching was indicated when the absolute standardized mean difference after matching was less than 0.25.[41] A matching ratio of 1:2 was used for active arts engagement (to get more appropriate comparators as the proportion of active arts engagement was smaller) and 1:1 was used for passive arts engagement. Model sensitivity was tested using the Rosenbaum Bounds for Hodges-Lehmann Point Estimate to assess how robust

the findings were to hidden bias due to unobserved covariates. The maximum Gamma (the odds of differential assignment to treatment due to unobserved factors) was set to two with increments of 0.1 to test at which point the between group differences were no longer robust.[42] All subsequent analyses were performed with the matched samples using methods appropriate for the analysis of matched data in estimating the impact of active or passive art as well as the statistical significance. Independent t-tests were used to assess the impact of active or passive art on wellbeing on participants, and effect size (*d*) was also reported between the treated and control group. All statistical analyses were performed by Stata version 14.2 for Windows (StataCorp, Texas, USA). A two-sided p-value less than 0.05 was considered as statistically significant.

RESULTS

Study participants' age ranged from 50 – 95 years (M=64.2, SD=10.0), with 45% males and 81% of Chinese ethnicity, of which were representative of Singapore's older population. 60% of participants reported attending at least one arts and culture activity within a time frame of six months (i.e. passive arts engagements), while 17% of the respondents reported actively participating in at least one arts and culture event within a timeframe of three months (i.e. active arts engagements). Overall, participants spent a median time of 6 hours attending arts events (IQR=11.0; range=0–258 hours) within a six-month time period, and a median time of 11 hours actively engaged in the arts (IQR=27.6; range=0–1015 hours) within a three-month time period. Top reported art forms among passive arts attendees in this sample included film (28%), heritage-related events (23%) and theatre (25%). As for active arts participants, engagements in visual arts (5%), music (4%) and craftwork (4%) were commonly reported. Detailed demographic information, physical activity levels and scores of all outcome variables are reported in table 1. For subsequent analysis, four outliers were identified and removed due to overtly high arts engagement hours (who may be professional artists or art enthusiasts), hence data from 1,063 participants were used for subsequent analyses. There were no missing data for the variables in this study.

Results from the correlational analyses indicated that passive arts engagement was associated with better wellbeing measures, specifically, quality of life (r=0.233, p<0.0001), perceived health (r=0.174, p<0.0001), social functioning (r=0.106, p=0.001), mental health (r=0.124, p<0.0001), spiritual wellbeing (r=0.162, p<0.0001) and interpersonal support (r=0.172, p<0.0001). Furthermore, active engagements in the arts were associated with better quality of life (r=0.177, p<0.0001), health perceptions (r=0.130, p<0.0001), role functioning (r=0.078, p=0.011), social functioning (r=0.100, p=0.001) and mental health (r=0.154, p<0.0001), as well as enhanced spiritual wellbeing (r=0.201, p<0.0001) and interpersonal support (r=0.116, p<0.0001). After adjusting for covariates in each model, findings from exploratory regression analyses indicated that passive engagement in the arts was a significant independent predictor of better quality of life (β=0.166, SE=0.008, p<0.0001), health perceptions (β=0.146, SE=0.035, p<0.0001), mental health (β=0.095, SE=0.028, p=0.002), spiritual wellbeing (β=0.128, SE=0.014, p<0.0001) and interpersonal support (β=0.101, SE=0.012, p=0.0003). Similarly, active engagement in the arts were also a significant predictor of quality of life (β=0.139, SE=0.006, p<0.0001), health perceptions (β=0.078, SE=0.026 p=0.006) and spiritual wellbeing (β=0.065, SE=0.011, p=0.023). Please refer to table 2 for more details regarding the exploratory correlational and regression analyses.

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Table 1. Characteristics of Respondents

Demographic Characteristic	N (%)	Variable Information	N (%) / Mean (SD)
Demographic Background		**Arts Engagement Frequency (n, %)**	
Gender		Active Arts Engagement	178 (16.7)
Male	479 (44.9)	Top reported: Visual Art	49 (4.6)
Female	588 (55.1)	Top reported: Music	43 (4.0)
Age at time of survey (years)		Top reported:Craftwork	41 (3.8)
50 - 59	421 (39.5)	Passive Arts Engagement	645 (60.4)
60 - 69	372 (34.9)	Top reported: Film	295 (27.6)
>70	274 (25.7)	Top reported: Theatre	270 (25.3)
Marital Status		Top reported: Heritage-related events	244 (22.9)
Single/Divorced/Widowed	216 (20.2)	**Physical Activity Levels (Mean, SD)**	
Married	851 (79.8)	Light Intensity (Range: 0–57)	5.3 (9.3)
Ethnicity		Moderate Intensity (Range: 0–60)	2.0 (6.1)
Chinese	859 (80.5)	Vigorous Intensity (Range: 0–10)	0.3 (1.0)
Malay	121 (11.3)	Strength and Balance (Range: 0–30)	0.7 (1.5)
Indian	78 (7.3)	Overall Physical Activity (Range: 0–87)	8.2 (12.4)
Others (E.g. Eurasian)	9 (0.8)	**Wellbeing Variables (Mean, SD)**	
Highest Obtained Education		Quality of Life (WHOQOL-8)[b] (Range: 11–40)	31.4 (4.2)
Up to Primary/Elementary School	678 (63.5)	SF20[c] - Health Perception (Range: 0–100)	69.9 (19.6)
Secondary/High School or Above	389 (36.5)	SF20 - Pain (Range: 0–80)	17.4 (20.0)
Employment Status		SF20 - Social Functioning (Range: 0–100)	90.8 (21.4)
Full-time / Self-employed	309 (29.0)	SF20 - Role Functioning (Range: 0–100)	87.9 (29.3)
Part-time employed	148 (13.9)	SF20 - Physical Functioning (Range: 0–100)	86.1 (23.0)
Unemployed or Retired	610 (57.2)	SF20 - Mental Health (Range: 0–100)	81.9 (14.7)
Monthly Household Income (SGD)[a]		Interpersonal Support (ISEL-S)[d] (Range: 12–48)	37.8 (6.6)
< 2,000	412 (38.6)	Appraisal Support Subscale (Range: 4–16)	12.7 (2.4)
2,000 - 3,999	335 (31.4)	Belonging Support Subscale (Range: 4–16)	12.3 (2.6)
≥ 4,000	320 (30.0)	Tangible Support Subscale (Range: 4–16)	12.9 (2.3)
Housing Type		Spiritual Wellbeing (FACIT-Sp-12)[e] (Range: 7–48)	34.0 (8.0)
1 / 2 / 3-room flat	308 (28.9)	Meaning Subscale (Range: 1–16)	12.4 (2.9)
4-room flat	378 (35.4)	Peace Subscale (Range: 2–16)	12.3 (2.8)
5-room/ 3-Gen/ Executive/ Mansionette	277 (26.0)	Faith Subscale (Range: 0–16)	9.3 (3.8)
Condominium and Others	104 (9.7)		
Living Arrangements			
Family (e.g. Spouse, Children, Siblings)	968 (90.7)		
Living alone	71 (6.7)		
Others (e.g. Friends, Tenants)	28 (2.6)		

[a] *SGD: Singapore Dollar,* [b]*WHOQOL-8: World Health Organization Quality of Life Instrument (8-item) ,* [c] *SF20: 20-Item Short Form Survey,* [d] *ISEL-S: Interpersonal Support Evaluation List – Short Form;* [e] *FACIT-Sp-12: Functional Assessment of Chronic Illness Therapy - Spiritual Well-Being; The 12-item Spiritual Well-Being Scale*

Table 2. Spearman Correlations and Multiple Regression Analyses Predicting Wellbeing

| Wellbeing Measures | Passive Arts Engagement | | | | | | Active Arts Engagement | | | | | |
| | Spearman Correlation | | Multiple Regression | | | | Spearman Correlation | | Multiple Regression | | | |
	r	p value	β	SE	p value	Adj. R^2	r	p value	β	SE	p value	Adj. R^2
Quality of Life (WHOQOL-8)	0.233	<0.0001*	0.166	0.008	<0.0001*	0.150	0.177	<0.0001*	0.139	0.006	<0.0001*	0.142
Holistic Health (SF20)												
SF20 - Health Perception	0.174	<0.0001*	0.146	0.035	<0.0001*	0.179	0.130	<0.0001*	0.078	0.026	0.006*	0.163
SF20 - Role Functioning	0.050	0.101	…	…	…	…	0.078	0.011*	…	…	…	…
SF20 - Pain Domain	-0.010	0.750	…	…	…	…	-0.024	0.430	…	…	…	…
SF20 - Social Functioning	0.106	0.0001*	…	…	…	…	0.100	0.0001*	…	…	…	…
SF20 - Physical Function	0.050	0.103	…	…	…	…	0.027	0.373	…	…	…	…
SF20 - Mental Health	0.124	<0.0001*	0.095	0.028	0.002*	0.069	0.154	<0.0001*	0.057	0.021	0.058	0.063
Spiritual Wellbeing (FACIT-SP-12)	0.162	<0.0001*	0.128	0.014	<0.0001*	0.177	0.201	<0.0001*	0.065	0.011	0.023*	0.164
Meaning Subscale	0.164	<0.0001*	0.121	0.005	<0.0001*	0.191	0.244	<0.0001*	0.081	0.004	0.004*	0.183
Peace Subscale	0.153	<0.0001*	0.123	0.005	<0.0001*	0.144	0.205	<0.0001*	0.094	0.004	0.001*	0.138
Faith Subscale	0.096	0.002*	0.084	0.007	0.003*	0.171	0.095	0.002*	0.004	0.005	0.896	0.164
Interpersonal Support (ISEL-S)	0.172	<0.0001*	0.101	0.012	0.0003*	0.180	0.116	<0.0001*	0.036	0.009	0.205	0.172
Appraisal Subscale	0.126	<0.0001*	0.086	0.004	0.003*	0.133	0.096	0.002*	0.030	0.003	0.299	0.127
Belonging Subscale	0.190	<0.0001*	0.123	0.005	<0.0001*	0.163	0.117	<0.0001*	0.043	0.003	0.134	0.150
Tangible Subscale	0.135	<0.0001*	0.059	0.004	0.039*	0.144	0.106	0.001*	0.022	0.003	0.439	0.141

*N= 1063, *p<0.05, Note: Variables which satisfied the normality tests are reported in the table; Covariates entered: age, gender, marital status, number of children, education, presence of religious belief, employment status, monthly household income, housing type, presence of chronic illness*

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Balancing information before and after propensity score matching is presented in the table 3. After matching, a total of 444 (treatment = 176 & control = 268) cohort participants were included in the analysis for active group and 730 (treatment = 365 & control = 365) were included in the analysis for passive group respectively. All included covariates achieved balance after matching in the PSM analysis except for age and some physical activity components, however these differences were minimal. For the active engagement group, the median bias prior to matching was 22.8% and that was reduced to 1.4% after matching. The median bias prior to matching for the passive engagement group was 15.1% and was reduced to 8.6% after matching. The unmatched units were dropped as the propensity score model did not find any appropriate control with respect to the case. The characteristics of matching variables between matched and unmatched samples in both active and passive engagement groups were further compared. Descriptive analysis showed that propensity score model clearly distinguished the samples with similar characteristics in matched group compared with the unmatched group (see supplementary Table S1). Model sensitivity analysis showed these results were acceptable and robust as Gamma value did not include zero in the lower and upper bounds when it increased to two.

Detailed findings of the t-tests conducted are presented in table 4. Results from independent-samples t-tests revealed that participants who engaged in the arts scored significantly better in multiple measures of wellbeing. For the passive engagement group, participants reported a significantly higher quality of life [t(728)=3.35, p=0.0008, d=0.25] and perceived health scores [t(728)=2.21, p=0.0277, d=0.16] than matched controls. Although there were no significant differences in overall social wellbeing, arts attendees reported an enhanced sense of belonging [t(728)=2.17, p=0.03, d=0.16] in the social wellbeing subscale than non-arts attendees. Independent-sample t-tests conducted with the active arts engagement group also revealed significant mean differences in quality of life [t(442)=3.68, p=0.0003, d=0.36], perceived health [t(442)=2.59, p=0.0099, d=0.25] and overall spiritual wellbeing [t(442)=3.75, p=0.0002, d=0.37]. Moreover, participants who actively participated in the arts also reported greater spiritual wellbeing subscale scores in meaning in life [t(442)=5.02, p<0.0001, d=0.50] as well as sense of peace [t(442)=3.72, p=0.0002, d=0.36] in comparison to matched controls. Finally, although marginally significant, active arts participants also reported better social functioning [t(442)=1.68, p=0.0939, d=0.17] and mental health [t(442)=1.84, p=0.0668, d=0.18].

Table 3. Distribution of Balance for Covariates Before and After Matching by Propensity Score Matching (PSM) in Passive and Active Engagement Groups

Balance variables	Passive Engagement						Active Engagement					
	Before matching (n = 1063)			After matching (n = 730)			Before matching (n = 1063)			After matching (n = 444)		
	Passive Group (n = 642)	Non- Passive Group (n = 421)	Unstandardized mean difference	Passive Group (n = 365)	Non-Passive Group (n = 365)	Standardized mean difference	Active Group (n = 176)	Non-Active Group (n =887)	Unstandardized Mean difference	Active Group (n = 176)	Non-Active Group (n =268)	Standardized mean difference
Age (years)	62.57	66.73	-4.15	66.47	65.02	1.46	61.60	64.74	-3.14	61.60	61.09	0.51
Sex												
Male respondents	0.42	0.49	-0.07	0.52	0.47	0.05	0.38	0.46	-0.09	0.38	0.36	0.01
Marital Status												
Married	0.81	0.77	0.04	0.77	0.79	-0.02	0.86	0.79	0.07	0.86	0.86	0.00
Highest Obtained Education												
Elementary school	0.49	0.56	-0.07	0.64	0.58	0.06	0.43	0.54	-0.11	0.43	0.43	-0.01
High School or Higher	0.43	0.27	0.15	0.23	0.31	-0.08	0.53	0.33	0.20	0.53	0.52	0.01
Ethnicity												
Chinese ethnic group	0.81	0.79	0.02	0.78	0.80	-0.02	0.84	0.80	0.04	0.84	0.86	-0.03
Religious Belief												
Have religious belief	0.88	0.86	0.02	0.86	0.86	-0.01	0.88	0.87	0.01	0.88	0.88	0.00
Employment Status												
Part-time employed	0.16	0.11	0.05	0.10	0.13	-0.03	0.20	0.13	0.08	0.20	0.19	0.02
Full-time or self-employed	0.32	0.25	0.07	0.25	0.27	-0.02	0.32	0.29	0.03	0.32	0.32	0.00
Monthly Household Income (SGD)												
1,000 - 2,999	0.29	0.32	-0.03	0.36	0.32	0.04	0.24	0.31	-0.08	0.24	0.24	0.00
>3,000	0.51	0.39	0.13	0.37	0.42	-0.05	0.54	0.45	0.09	0.54	0.53	0.01
Housing Type												
3-4 room HDB Flat	0.55	0.62	-0.06	0.65	0.62	0.03	0.47	0.60	-0.13	0.47	0.46	0.01
5 room HDB Flat and others	0.38	0.31	0.07	0.28	0.32	-0.04	0.49	0.33	0.17	0.49	0.50	0.00
Physical Activity Levels (Hours)												
Light Intensity	6.49	3.43	3.06	2.52	3.69	-1.17	9.09	4.52	4.57	9.09	8.97	0.13
Moderate Intensity	2.46	1.42	1.04	1.02	1.59	-0.56	3.30	1.80	1.50	3.30	3.33	-0.03
Vigorous Intensity	0.32	0.16	0.16	0.11	0.16	-0.05	0.51	0.20	0.31	0.51	0.53	-0.02
Strength and Balance	0.78	0.51	0.26	0.46	0.56	-0.11	1.00	0.61	0.39	1.00	0.84	0.16
All Physical Activities	10.05	5.52	4.52	4.11	6.01	-1.90	13.91	7.13	6.78	13.91	13.68	0.23

Table 4. Group Differences in Wellbeing Scores

Wellbeing	Passive Arts Engagement[a]					Active Arts Engagement[b]				
	Passive (Mean ± SD)	Control (Mean ± SD)	t(728)	p	Effect Size(d)	Active (Mean ± SD)	Control (Mean ± SD)	t(442)	p	Effect Size(d)
Quality of Life (WHOQOL-8)	31.5 ± 4.15	30.5 ± 4.2	3.35	0.0008*	0.25	33.0 ± 4.16	31.5 ± 4.14	3.68	0.0003*	0.36
Short Form Health Survey (SF-20)										
SF20 - Health Perception	69.6 ± 19.9	66.3 ± 21.1	2.21	0.028*	0.16	75.5 ± 18.2	70.7 ± 19.3	2.59	0.0099*	0.25
SF20 - Role Functioning	85.4 ± 31.2	86.4 ± 31.7	0.44	0.659	0.03	92.8 ± 24.2	91.1 ± 26.1	0.66	0.512	0.06
SF20 - Pain Domain	18.1 ± 20.9	17.8 ± 20.7	0.18	0.859	0.01	16.7 ± 20.6	17.9 ± 19.6	0.62	0.538	0.06
SF20 - Social Functioning	90.9 ± 19.6	88.9 ± 24.5	1.20	0.230	0.09	95.6 ± 14.7	92.8 ± 18.7	1.68	0.094	0.17
SF20 - Physical Function	84.9 ± 22.2	84.4 ± 25.2	0.27	0.785	0.02	89.2 ± 18.6	88.5 ± 20.9	0.37	0.715	0.04
SF20 - Mental Health	81.2 ± 14.8	80.5 ± 15.4	0.63	0.532	0.05	86.0 ± 13.1	83.6 ± 14.0	1.84	0.067	0.18
Interpersonal Support (ISEL-S)	37.4 ± 6.3	36.8 ± 6.4	1.14	0.253	0.08	39.4 ± 6.9	38.7 ± 6.4	1.10	0.273	0.11
Appraisal Subscale	12.4 ± 2.3	12.4 ± 2.4	0.32	0.751	0.02	13.1 ± 2.6	12.9 ± 2.4	0.70	0.483	0.07
Belonging Subscale	12.2 ± 2.5	11.8 ± 2.6	2.17	0.030*	0.16	12.9 ± 2.6	12.6 ± 2.4	1.16	0.246	0.11
Tangible Subscale	12.7 ± 2.2	12.6 ± 2.3	0.44	0.658	0.03	13.4 ± 2.5	13.1 ± 2.2	1.12	0.262	0.11
Spiritual Wellbeing (FACIT-Sp-12)	33.5 ± 8.0	33.1 ± 8.1	0.68	0.496	0.05	37.5 ± 7.2	34.7 ± 7.7	3.75	0.0002*	0.37
Meaning Subscale	12.2 ± 2.8	12.1 ± 3.0	0.12	0.908	0.01	13.9 ± 2.3	12.6 ± 2.8	5.03	<0.0001*	0.50
Peace Subscale	12.1 ± 2.7	11.9 ± 3.0	0.81	0.419	0.06	13.5 ± 2.6	12.5 ± 2.7	3.72	0.0002*	0.36
Faith Subscale	9.3 ± 3.9	9.0 ± 3.9	0.73	0.464	0.05	10.1 ± 4.0	9.6 ± 3.8	1.25	0.211	0.12

[a]n = 730, [b]n = 444; *p<0.05

DISCUSSION

This was the first-ever empirical research that examined arts engagements and its impact on holistic wellbeing among current and future elderly populations in Asia using naturalistic observational data with PSM analysis. This study established significantly strong causal relationships between arts engagements (both passive and active engagements) and numerous domains of holistic wellbeing in a naturalistic sample of older adults in Singapore. The results revealed that by passively engaging in the arts, older adults experienced significantly higher quality of life, better perceived health and greater social connectedness as compared to non-art attendees. The results further showed that older adults who actively engaged in the arts experienced significantly enhanced quality of life, better perceived health, stronger spiritual wellness, life meaning and peace with a medium effect size, as compared to non-art participants. These findings support that varying depths of arts engagements could impact different domains of holistic wellness among older adults, where both passive exposures to and active engagements in the arts could bring about quality of life and subjective health benefits.

The findings from this study also supported past literature, [43-45] and provided novel contributions to the growing research on arts, health and wellness. Firstly, the present study adopted a holistic view and assessed multiple domains of wellbeing including quality of life, perceived health and mental health, social support and spiritual wellness, whereas past studies only examined the effects of the arts on one or a very selected few facets of wellbeing.[10,11,43-45] Secondly, the present study included an extensive range of art forms with specific cultural genres (e.g. 'angklung' – bamboo flute, 'wayang kulit' – shadow puppets, and Chinese operas) to investigate its effects on health and wellness among a specific cohort of current and soon-to-be older adults between the ages of 50 and 95, as well as employed a stratified random survey method to recruit a sizable sample that was highly representative of Singapore's elderly population. Thus, the results generated had strong generalizability to local populations and provided policy makers, practitioners and researchers with age and cultural-specific insights on programme development.[46] The results could also serve as a frame of reference for the advancement of other Asian societies that share similar socio-cultural demographics and structures such as Hong Kong, Malaysia and other major cities in China. Finally, through propensity score matching, participants engaged in the arts were systematically matched on multiple covariates with respondents who did not engage in the arts. This allowed for meaningful comparisons between groups in a naturalistic sample, of which is greatly lacking in the literature on arts, health and wellness. To our knowledge, this is the first arts and health study that employed this analytical method.

One can connect to literature on creativity, self-mastery, relational aesthetics and neurological sciences for the inner workings of arts and wellness. Arts engagement fosters an empowering process of creativity and autonomy that cultivates mindful-awareness, self-understanding and new insights.[47] This in turn facilitates motivation for narrative identity processing,[48] a constructive reflection process of character building that fosters life meaning and self-affirmation, leading to the development of self-mastery.[49,50] Through arts engagements, individuals would also encounter relational aesthetics, an experience of emotional connections via metaphoric dialogue with the arts and the artists that broadens perspectives and nurtures diversity, while inspiring human connections, empathy and compassionate citizenry.[51,52] Arts engagement may also have a role to play in stimulating the parasympathetic nervous system, leading to a greater sense of peace and relaxation.[53] Finally, neurological literature has illustrated the effects of arts as a means for stimulating

neuroplasticity and building cognitive reserve.[54,55] As such, it is evident that the arts can positively impact various domains of wellbeing through numerous psychosocial processes, particularly for older adults whose sense of identity and personhood progressively decline with the onset of old age, worsening health and diminishing social networks.[56]

Future arts-based elderly care programmes may target these avenues and pathways for wellness promotion. The findings show that attending art events could reap social and relational benefits for tackling social isolation, while creating art could harness intrinsic benefits that lead to spiritual fulfillment and growth. From a policy perspective, this translates into multiple entry points for attracting and maintaining arts participation among older populations. Thus, considerations for a formal and sustainable structure that incorporates participatory art initiatives and programmes into aged care services, while ensuring proficient training of more community art workers to support these works could be made as this would be a cost-effective way to promote healthy, creative and meaningful ageing. Despite the positive effects of creative arts engagement on health, it has been repeatedly found that promoting engagement in the arts among the elderly is difficult, as participation in the arts generally declines with age, most progressively among individuals reaching age of 65, and most markedly for those aged 75 and above.[57] Similar findings have also been reported in Singapore, where older adults aged 60 and above had the lowest art attendance and art participation rates among all age cohorts.[58] Within this sample, art participation rates among adults aged 50 and above was 17%. This trend is disconcerting given the fact that the arts could play a significant role in supporting well-being in old age. From a practice perspective, participatory arts programmes and initiatives could include public education and advocacy campaigns to promote arts engagements, art-based psychosocial care programming designed for community and residential care settings, as well as collaboration with arts and cultural heritage intuitions in developing arts programmes that are fitting to the needs and interests of older adults. Practitioners and health care providers could consider the arts as a non-medical, non-pharmaceutical agent for mental health and quality of life enhancement, and may also consider integrating passive art activities to enhance social programmes for older adults. Finally, the arts may also be considered as a gateway to support stronger social networks for tackling the public health problem of loneliness through programmes that use the arts as platforms for outreach, relational bonding and community building.

The results of this study, although theoretically and practically appealing, were not without its limitations. Firstly, potential confounders were balanced in the PSM except for age and frequency of light intensity physical activity, hence caution must be exercised when interpreting the results. Moreover, despite having model sensitivity analyses conducted for unobserved covariates, the presence of other potential confounding variables in this study such as the presence competing social activities, recreational and religious activities, as well as living arrangements should be assessed and controlled for in future research. Secondly, the arts engagement assessment items required the accuracy of memory recall (three to six months prior to data collection) from the participants and the psychometric measures were self-reported. Future research could consider administering objective measures of arts engagement such as clinical observations and activity journals, as well as health service utilization and functional magnetic resonance imaging (fMRI) to assess the objective health and wellbeing outcomes. Finally, the current study employed cross-sectional survey data that assessed participants at a single time point, and thus was not possible to rule out the potentiality of reverse

causality. For example, while our findings reveal that art attendance enhances one's sense of belonging, the opposite may hold true where a sense of belonging could be a precursor to art attendance, implying that programme design and implementation would need to target both enablers, namely to facilitate belonging and making art appealing. In order to obtain a deeper understanding of the causal and directional effects of arts engagement, future studies should consider implementing a robust experimental or longitudinal research design. Despite these limitations, the findings generated from this study are important starting points for future empirical research in Singapore and neighboring regions, as they provide a critical cross-cultural understanding on the relationship between arts and wellness in greater Asia, while contributing to the growing literature on the subject matter internationally.

In conclusion, the arts can play a significant role in sustaining a healthy, active and resilient elderly populace with greater cost-efficiency than traditional medicine and health service models. Under the rubric of rapid population ageing, the need for more evidence-driven arts promotion initiatives to foster active and creative ageing, as well as greater art-based psychosocial care for the elderly is urgently warranted in Asia and around the globe.

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AUTHOR CONTRIBUTIONS

In terms of author contributions, AHYH, MHRH, JSP and EO designed the study and obtained funding, SHXM carried out literature search and data collection, RCB carried out data analysis, all authors contributed to data interpretation, as well as the writing and revision of the manuscript.

COMPETING INTERESTS

ROLE OF THE FUNDING SOURCE

DATA AVAILABILITY STATEMENT

No additional data available.

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Table S1: Comparison of background variables between matched and unmatched samples in active and passive engagement groups

Variables	Active engagement			Passive engagement		
	Unmatched (n = 619)	Matched (n = 444)	P-value	Unmatched (n = 333)	Matched (n = 730)	P-value
Age (years)	66.4 ± 10.6	61.2 ± 8.3	<0.001	66.4 ± 11.1	63.2 ± 9.4	<0.001
Sex			<0.001			0.173
Male	308 (49.8)	170 (38.3)		160 (48.1)	318 (43.6)	
Female	311 (50.2)	274 (61.7)		173 (51.9)	412 (56.4)	
Marital Status			0.001			0.037
Single	147 (23.7)	68 (15.3)		80 (24.0)	135 (18.5)	
Married	472 (76.3)	376 (84.7)		253 (76.0)	595 (81.5)	
Educational status			<0.001			<0.001
No Formal Education	110 (17.8)	15 (3.4)		57 (17.1)	68 (9.3)	
Elementary school	341 (55.1)	210 (47.3)		176 (52.9)	375 (51.4)	
High school or Higher	168 (27.1)	219 (49.3)		100 (30.0)	287 (39.3)	
Ethnicity			0.010			0.758
Non-Chinese	137 (22.1)	70 (15.8)		63 (18.9)	144 (19.7)	
Chinese	482 (77.9)	374 (84.2)		270 (81.1)	586 (80.3)	
Religious belief			0.351			0.498
No religious belief	86 (13.9)	53 (11.9)		47 (14.1)	92 (12.6)	
Have a religious belief	533 (86.1)	391 (88.1)		286 (85.9)	638 (87.4)	
Employment status			<0.001			0.009
Unemployed/retired	388 (62.6)	219 (49.3)		213 (64.0)	394 (54.0)	
Part time employment	61 (9.9)	86 (19.4)		39 (11.7)	108 (14.8)	
Full time/ self-employed	170 (27.5)	139 (31.3)		81 (24.3)	228 (31.2)	
Monthly household income (SGD)			0.001			0.004
<1,000	164 (26.5)	86 (19.4)		96 (28.8)	154 (21.1)	
1,000 - 2,999	197 (31.8)	124 (27.9)		106 (31.8)	215 (29.5)	
>3,000	258 (41.7)	234 (52.7)		131 (39.4)	361 (49.4)	
Housing type			<0.001			0.099
1-2 room HDB flat	55 (8.9)	14 (3.2)		29 (8.7)	40 (5.5)	
3-4 room HDB flat	389 (62.8)	226 (50.9)		194 (58.3)	421 (57.7)	
5 room HDB flat and others	175 (28.3)	204 (45.9)		110 (33.0)	269 (36.8)	
Physical activity level (hours)						
Light intensity (mean ± s.d.)	4.1 ± 7.4	6.9 ± 11.3	0.0002	4.6 ± 9.4	5.6 ± 9.3	0.023
Moderate intensity (mean ± s.d.)	1.7 ± 5.7	2.5 ± 6.6	0.0001	1.6 ± 5.2	2.2 ± 6.5	0.005
Vigorous intensity (mean ± s.d.)	0.2 ± 0.8	0.3 ± 1.2	0.015	0.2 ± 0.9	0.3 ± 1.0	0.009
Strength and balance (mean ± s.d.)	0.6 ± 1.6	0.8 ± 1.4	0.010	0.6 ± 1.9	0.7 ± 1.3	0.105
All physical activity (mean ± s.d.)	6.6 ± 10.6	10.5 ± 14.4	<0.001	7.1 ± 12.1	8.8 ± 12.6	0.0002

The Arts for Ageing Well: A Propensity Score Matching Analysis of the Effects of Arts Engagements on Holistic Wellbeing among Older Asian Adults above 50 years of age

Last Update: 22 Aug 2019

STROBE Statement—Checklist of items that should be included in reports of *cross-sectional studies*

	Item No	Recommendation	Reported on Manuscript Page (Section)
Title and abstract	1	(*a*) Indicate the study's design with a commonly used term in the title or the abstract	1 (Title)
		(*b*) Provide in the abstract an informative and balanced summary of what was done and what was found	2 (Abstract)
Introduction			
Background/rationale	2	Explain the scientific background and rationale for the investigation being reported	3,4 (Introduction)
Objectives	3	State specific objectives, including any prespecified hypotheses	4 (Research Objectives)
Methods			
Study design	4	Present key elements of study design early in the paper	5 (Study Design and Participants)
Setting	5	Describe the setting, locations, and relevant dates, including periods of recruitment, exposure, follow-up, and data collection	5 (Study Design and Participants)
Participants	6	(*a*) Give the eligibility criteria, and the sources and methods of selection of participants	5 (Study Design and Participants)
Variables	7	Clearly define all outcomes, exposures, predictors, potential confounders, and effect modifiers. Give diagnostic criteria, if applicable	5 (Study variables)
Data sources/ measurement	8*	For each variable of interest, give sources of data and details of methods of assessment (measurement). Describe comparability of assessment methods if there is more than one group	6 (Study variables)
Bias	9	Describe any efforts to address potential sources of bias	7,8 (Statistical Analysis)
Study size	10	Explain how the study size was arrived at	4 (Study Design and Participants)
Quantitative variables	11	Explain how quantitative variables were handled in the analyses. If applicable, describe which groupings were chosen and why	7 (Statistical Analysis)
Statistical methods	12	(*a*) Describe all statistical methods, including those used to control for confounding	7,8 (Statistical Analysis)
		(*b*) Describe any methods used to examine subgroups and interactions	7,8 (Statistical Analysis)
		(*c*) Explain how missing data were addressed	8 (Results)
		(*d*) If applicable, describe analytical methods taking account of sampling strategy	5 (Study Design and Participants)
		(*e*) Describe any sensitivity analyses	8 (Methods) 11 (Results)

The Arts for Ageing Well: A Propensity Score Matching Analysis of the Effects of Arts Engagements on Holistic Wellbeing among Older Asian Adults above 50 years of age

Results			
Participants	13*	(a) Report numbers of individuals at each stage of study—eg numbers potentially eligible, examined for eligibility, confirmed eligible, included in the study, completing follow-up, and analysed	5 (Methods; Procedures)
		(b) Give reasons for non-participation at each stage	5 (Methods; Procedures)
		(c) Consider use of a flow diagram	N.A.
Descriptive data	14*	(a) Give characteristics of study participants (eg demographic, clinical, social) and information on exposures and potential confounders	8 (Results), 9 (Table 1)
		(b) Indicate number of participants with missing data for each variable of interest	8 (Results)
Outcome data	15*	Report numbers of outcome events or summary measures	8 (Results), 9 (Table 1)
Main results	16	(*a*) Give unadjusted estimates and, if applicable, confounder-adjusted estimates and their precision (eg, 95% confidence interval). Make clear which confounders were adjusted for and why they were included	12 (Table 3)
		(*b*) Report category boundaries when continuous variables were categorized	N.A.
		(*c*) If relevant, consider translating estimates of relative risk into absolute risk for a meaningful time period	N.A.
Other analyses	17	Report other analyses done—eg analyses of subgroups and interactions, and sensitivity analyses	8 (Methods) 10 (Results)
Discussion			
Key results	18	Summarise key results with reference to study objectives	14 (Discussion)
Limitations	19	Discuss limitations of the study, taking into account sources of potential bias or imprecision. Discuss both direction and magnitude of any potential bias	15 (Discussion)
Interpretation	20	Give a cautious overall interpretation of results considering objectives, limitations, multiplicity of analyses, results from similar studies, and other relevant evidence	14, 15 (Discussion)
Generalizability	21	Discuss the generalizability (external validity) of the study results	14, 15 (Discussion)
Other information			
Funding	22	Give the source of funding and the role of the funders for the present study and, if applicable, for the original study on which the present article is based	16 (Role of the Funding Source)

*Give information separately for exposed and unexposed groups.

The Arts for Ageing Well: A Propensity Score Matching Analysis of the Effects of Arts Engagements on Holistic Wellbeing among Older Asian Adults above 50 years of age

Note: An Explanation and Elaboration article discusses each checklist item and gives methodological background and published examples of transparent reporting. The STROBE checklist is best used in conjunction with this article (freely available on the Web sites of PLoS Medicine at http://www.plosmedicine.org/, Annals of Internal Medicine at http://www.annals.org/, and Epidemiology at http://www.epidem.com/). Information on the STROBE Initiative is available at www.strobe-statement.org.

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The Arts for Ageing Well: A Propensity Score Matching Analysis of the Effects of Arts Engagements on Holistic Wellbeing among Older Asian Adults above 50 years of age

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The Arts for Ageing Well: A Propensity Score Matching Analysis of the Effects of Arts Engagements on Holistic Wellbeing among Older Asian Adults above 50 years of age

Andy Hau Yan Ho[1, 2*], Stephanie Hilary Xinyi Ma[1], Moon-Ho Ringo Ho[1], Joyce Shumin Pang[1], Emily Ortega[3], Ram Chandra Bajpai[2,4]

[1]Psychology Programme, School of Social Sciences, Nanyang Technological University, Singapore.

[2]Centre for Population Health Sciences, Lee Kong Chian School of Medicine, Nanyang Technological University, Singapore.

[3]Psychology Programme, School of Humanities and Behavioral Sciences, Singapore University of Social Sciences, Singapore.

[4]School of Primary, Community and Social Care, Keele University, Staffordshire, UK ST5 5BG

* Correspondence to: Dr Andy Hau Yan Ho, School of Social Sciences, 48 Nanyang Avenue, HSS-04-03, Singapore 639818. Email: andyhyho@ntu.edu.sg   Tel: +65 6316 8943

(Manuscript Word Count: 4,858)

Abstract

Objective: To assess the frequency and intensity of arts engagement inclusive of active and passive engagements in arts, culture and heritage activities among Singaporean adults aged 50 and above, and examine the relationships between participatory art and holistic wellbeing.

Design: Cross-sectional stratified household survey.

Setting: All residential areas across Singapore's Central, East, North, North-East and West Regions.

Participants: 1,067 community-dwelling, Singaporean older adults between the ages of 50-95 years were recruited.

Primary and secondary outcome measures: Respondents completed a self-reported questionnaire, consisting of standardized ad hoc items assessing the frequencies and durations of active and passive participatory arts engagement, as well as validated psychometric assessments on psycho-socio-spiritual health including the primary outcome measure on quality of life, and the secondary outcome measures on physical, psychological, emotional, spiritual, and social well-being. Socio-demographic information, as well as frequency and intensity of physical activity were also collected.

Results: Passive engagement (60%) and active engagement (17%) in the arts were associated with better holistic wellness and social support. Specifically, findings from the propensity score matching (PSM) and independent t-test analyses revealed that adults aged 50 and above who passively engaged in arts and culture-related events experienced higher quality of life [$t(728)=3.35$, $p=0.0008$, $d=0.25$], perceived health [$t(728)=2.21$, $p=0.0277$, $d=0.16$], and sense of belonging [$t(728)=2.17$, $p=0.03$, $d=0.16$], as compared to those who did not. Moreover, those who actively engaged in participatory arts experienced greater quality of life [$t(442)=3.68$, $p=0.0003$, $d=0.36$], self-rated health [$t(442)=2.59$, $p=0.0099$, $d=0.25$], spiritual wellbeing [$t(442)=3.75$, $p=0.0002$, $d=0.37$], meaning in life [$t(442)=5.02$, $p<0.0001$, $d=0.50$], and sense of peace [$t(442)=3.72$, $p=0.0002$, $d=0.36$], as compared to those who did not actively engaged in the arts.

Conclusion: This study provided robust evidence to support a significant causal relationship between arts engagements and holistic wellbeing. Recommendations for art-based public health and elderly care research, practice and policy are discussed.

Keywords: *Holistic wellbeing; Creative ageing; Participatory art; Propensity score matching; Public Health, Mental Health; Asia*

STRENGTHS AND LIMITATIONS OF THIS STUDY

- First-ever empirical research to date that examined arts engagements and its impact on holistic wellbeing in Asia using naturalistic observational data.
- Sample was a large, representative older adult population in Singapore
- Propensity score matching (PSM) analysis was conducted to reduce selection bias and avoid issues of endogeneity, allowing for comparisons between art-active groups and non-art-active groups.
- A wide range of art forms were assessed, of which included active engagements and passive consumption of eight art forms - music, dance, theatre, literary arts, visual arts, heritage activities, film, and craft events.
- The current study employed cross-sectional survey data that assessed participants at a single time point, and thus is not possible to rule out the potentiality of reverse causality.

INTRODUCTION

Asia is ageing at a much faster rate than anywhere else in the world.[1] In Singapore specifically, the proportion of adults aged 65 and above has more than doubled in the past two decades from 6% in 1990 to 13% in 2017. This trend will exponentially increase to approximately 25% by 2030.[2] Longevity, however, does not necessarily reflect better health at old age. According to recent statistics, 60% of Singaporeans aged 50 and above suffered from a chronic illness such as diabetes, heart disease and stroke, while 10% of adults aged 60 and above, as well as 50% of adults aged 85 and above were affected by dementia.[3, 4] Additionally, 51% of Singaporeans above the age of 60 reported feelings of loneliness and were at a greater risk of mortality.[5] These numbers reflect greater demands for health and social care services among the aged in the foreseeable future.

While traditional biomedical models have focused predominantly on supporting elderly health through curative interventions and rehabilitation services, contemporary public health approaches emphasize a health-promoting paradigm for maintaining and elevating holistic wellbeing, through cultivating personal autonomy, social participation and community involvement.[6] One has to look no further than to the Arts to realize its vital significance in cultivating these goals, as engagements in the cultural heritage of music, dance, theatre, literature as well as the visual arts have been known to have tangible effects on health and quality of life, whereby the agents of creativity and imagination can help "keep individual resilience, aid recovery and foster a flourishing society" (p.3).[7] Despite the extensive use of the arts for its therapeutic properties across history, research investigating healthy and active ageing through arts engagement were fairly recent.[8]

To consolidate existing research that investigated the relationship between arts engagement, health wellbeing and ageing, a literature search was conducted through PsycInfo, Web of Science, Social Science Citation Index, PubMed, and Medline. Relevant reports and studies published by governments and related organizations were also examined. Overall, the research team found robust evidence to support the efficacy of the arts in promoting wellness. Most notably, the Creative Health inquiry report published in the United Kingdom, which examined over 1,000 peer-reviewed and grey literature, concluded that not only can the arts bring various health and mental health benefits to people of all ages, it can also serve to address health and social care challenges in greater society such as ageing, longer-term conditions and loneliness.[9] Among studies that focused on community dwelling older adults, multiple reviews of empirical research that studied the

relationships between art-based interventions and healthy ageing revealed that active engagements in various forms of art produced positive cognitive, affective, and quality of life outcomes.[10,11] For instance, a randomized controlled trial on participatory singing activities reported its effectiveness in enhancing quality of life, and reducing anxiety and depression among older intervention participants. [12] Moreover, the Museums on Prescription Study showed that cultural heritage engagements were effective in improving psychological and social wellbeing.[13,14] Moreover, the efficacy of the arts in the treatment of mental health conditions, as well as support for the treatment of various chronic health conditions were well documented.[15,16] Numerous systematic reviews also suggested that various forms of participatory art activities were beneficial for persons with dementia living in residential care settings, serving to enhance cognitive processes, attention, mood and memory.[17, 18] Specifically, musical activities yielded better episodic memory and mood among patients with early dementia in a recent randomized controlled trial.[19] Finally, although limited, art and cultural heritage-based intervention studies with Asian populations have also shown similar positive results in psychological wellbeing.[20]

Despite robust evidence on the benefits of art-based interventions applied in the abovementioned settings, much less research has examined the impact of arts engagements in naturalistic settings.[21] In fact, many studies employed simple pre-and-post intervention designs without control groups, while others employed relatively small sample sizes that prevented meaningful comparisons.[11] Often, participants of these studies were recruited via convenience sampling rather than random sampling, potentially resulting in response biases.[15] With a rapidly ageing population around the globe and in Asia, there is a need to understand the landscape of arts engagement and to investigate the relationships between arts engagement and holistic well-being for advancing practices and policies that promote healthy and creative ageing. The "Arts for Ageing Well" study was the first-ever attempt to critically address this important knowledge gap by utilizing a holistic investigative approach with both quantitative and qualitative methodologies for exploring and understanding the notion of ageing well with the arts in Asia. This article reports the quantitative findings of the Arts for Ageing Well study.

Research Objectives

The specific objectives of this study were to (i) assess the frequency and intensity of arts engagement inclusive of active and passive engagements in music, dance, theatre, literary arts, visual arts, film, heritage events and activities, and craft events among Singaporean adults aged 50 and above, and to (ii) examine the relationships between participatory art and holistic well-being in terms quality of life, physical, psychological, emotional, spiritual, and social well-being.

METHODS

Study Design and Participants

1,067 participants were recruited between July 2016 and February 2017 across all regions of Singapore via a cross-sectional stratified random household survey to ensure sample representativeness of the national population. Sample size calculation was based on power analysis; a sample size of 1,067 allowed for ± 3% accuracy at the 95% confidence level. A sampling frame comprising all residential dwelling units with at least one resident aged 50 and above, spanning across all geographical areas demarcated by the Urban

Redevelopment Authority as residential areas that covered Singapore's Central, East, North, North-East and West Regions, was obtained from the Singapore Department of Statistics. Dwelling units were grouped into four non-overlapping strata according to age group, and were further stratified into gender, ethnicity, and housing types. Based on the resulting Master List, a fixed number of dwelling units were selected by a systematic sampling procedure with a random start. The inclusion criteria were community dwelling Singapore residents, who were able to communicate in either English, Malay, Mandarin, Tamil, Hokkien or Cantonese. The exclusion criteria were individuals who were visibly too ill or frail to participate or were unable to provide informed consent due to cognitive impairment as assessed by a screening question during recruitment and continuous observation throughout a face-to-face survey interview.

Procedures

Potential participants were selected from the master list in a sequential order and were contacted in-person through door-to-door home visits across Singapore. A minimum of three attempts were made to contact participants, before moving to the next participant in the master list. Upon initial contact, successfully engaged participants were informed of the study's background, rationale and details of their participation. Only one adult above the age of 50 was recruited from each randomly selected household. After informed consent, participants completed a standardized survey on arts engagement and holistic wellbeing via a 30 to 45-minute structured face-to-face interview. Each survey was conducted at the home of the participant, and each participant received a cash voucher of SGD$20 upon completion of the survey. The response rate for this study was 59%. 1,797 households with current or soon-to-be older adults were contacted to participate in the study; 68 interested individuals (4%) did not meet the inclusion criteria, 662 potentially eligible participants (37%) declined to participate in the study or dropped out, 1,067 (59%) eligible and consenting participants were recruited and completed the survey.

Ethical considerations

Ethical approval was obtained through Nanyang Technological University's Institutional Review Board before study commencement (IRB-2016-05-027). All participants were briefed and interviewed by trained interviewers who received regular supervision. Individual written consent was obtained prior to data collection.

Patient and Public Involvement

Research participants were not involved in the development of the research question, design, recruitment processes and conduct of the study. The findings of the study were disseminated locally via press coverage, and media interviews and conference presentations.

Study variables

Arts Engagement

A series of standardized ad hoc items were developed to assess the frequency and duration of arts engagement among study participants, of which included active engagements and passive consumption of eight specific art forms – music, dance, theatre, literary arts, visual arts, heritage activities, film and handicraft.[22]

Arts engagement was measured in terms of active engagement and passive engagement. Active engagement was construed as the active participation in art, heritage and cultural activities such as creating, while passive engagement referred to passive behaviors such as attending, viewing or listening.[23] Some examples of engagement in the study included attendance or participation in theatre events (e.g. attending musicals, performance in traditional theatre), music activities (e.g. listening to classical music, playing a musical instrument), dance performances (e.g. watching a ballet performance, participating in line dancing classes), visual arts activities (e.g. visiting art fairs, doing photography), heritage-related activities (e.g. visiting heritage buildings and monuments, providing guided cultural tours to others), literary arts-related events (e.g. attending a book launch, writing biographies), film-related events (e.g. attending a film festival, participating in a local film production) and craft activities (e.g. watching a handicraft demonstration, teaching embroidery classes). Participants were asked to recount their active engagements over the past three months and passive engagements over the past six months since the time of survey to facilitate accurate recall and comprehensive recording of all art activities. This difference in timeframe in assessing passive and active art engagement was due to the nature of engagement; existing research has shown that the frequency and duration for passive arts engagement were typically much sparser than active arts engagement,[24] and therefore a longer recall timeframe served to capture sufficient data for analysis. Overall scores of the total hours of active and passive arts engagement were calculated for each participant.

Covariates

To better understand the potential interplay between arts engagement and physical activity on well-being, a series of standardized items based on Singapore's National Physical Activities Guidelines,[25] was developed to assess the frequency and intensity of physical activity engagement among study participants. These items reflect light-intensity lifestyle activities such as walking, moderate-intensity physical activities (e.g. low-impact aerobics), vigorous-intensity physical activity (e.g. jogging), and strength and balance activities (e.g. Tai Chi). To determine whether medical and demographic variables were potential confounding factors, participant's clinical health information were assessed via self-reported presence of chronic illness and time since diagnosis. Demographic data including age, gender, marital status, family composition, socio-economic status and religion were also collected.

Outcome variables

Outcome variables measured and reported in the current study included quality of life and holistic wellbeing inclusive of the physical, mental, spiritual, and social domains. Quality of life was assessed using the 8-item World Health Organization Quality of Life Instrument (WHOQoL-8).[26] The WHOQoL-8 is a highly reliable 8-item scale ($\alpha = 0.86$) that measured participants' perceived quality of life domains including health, energy for everyday life, ability to perform daily activities, satisfaction with self, satisfaction with relationships, personal finances, living conditions and overall quality of life. Scores ranged from 8 – 40, with higher values representing better quality of life. Physical and mental wellbeing were assessed using the Short Form 20 (SF-20) Health Survey.[27] The SF-20 comprised of 20 items that measured six health domains including the subscales of health perceptions, physical role functioning, presence of bodily pain, perceived social functioning, physical functioning and mental health. Item scores were transformed individually and linearly, and were averaged for

final domain scores used for analyses. Higher values represented better self-reported health for all subscales, except for the bodily pain subscale, where higher values represented more reported bodily pain. Spiritual wellbeing was assessed using the 12-item Functional Assessment of Chronic Illness Therapy - Spiritual Wellbeing (FACIT-SP-12). The FACIT-SP-12 is a reliable scale ($\alpha = 0.87$) which measured the three domains of meaning, peace and faith.[28] Possible scores ranged from $0 - 48$, with higher scores indicating better spiritual wellbeing. Social wellbeing was assessed using the Interpersonal Support Evaluation List Short Form (ISEL-S).[29] The 12-item ISEL-S is a highly reliable scale ($\alpha = 0.90$) which measured the three domains of appraisal support, belonging support and tangible support. Overall scores were calculated for the analyses, with higher scores representing better social wellbeing. As Singapore is a multi-lingual society, the questionnaire was prepared in English, Malay, Chinese and Tamil. The Chinese versions of the WHOQOL-8, ISEL-S, SF20 and FACIT-SP scales, as well as the Malay version of the WHOQOL-8 were adapted from past studies with Asian older adults.[30-34] The other scales were translated to Malay and Tamil by a professional translator, back-translated, pilot tested and verified by the research team.

Statistical Analysis

Descriptive analyses were performed on all demographic, arts engagement, physical activity and outcome variables. Bivariate correlations and exploratory multiple linear regression analyses were conducted to understand the association between passive and active arts engagement, and various factors of holistic wellbeing. Socio-demographic variables including age, gender, marital status, number of children, highest education achieved, employment status, household income, housing type, and presence of chronic illness were adjusted for in each model.

Propensity score matching (PSM) analysis was adopted to reduce selection bias and avoid issues of endogeneity.[35] To approach a random distribution and to reduce the effect of covariates on the results, a propensity score was used to transform all matching variables to a conditional probability for balancing the covariates between the arts engagement group and the control group. [36] A propensity score was calculated for active arts engagement and non-active arts engagement groups, as well as passive arts engagement and non-passive arts engagement groups within the study period (i.e., average treatment effect on the treated (ATT)), using a logistic regression model. The covariates entered into the propensity score included demographic characteristics (age, sex, education, occupation, religion, income, house type) and physical activity variables (light-intensity, moderate-intensity, vigorous-intensity, strength and balance, as well as all physical activities). Covariate selection in the propensity model was based on the criterion suggested by Brookhart et al.[37] All meaningful covariates (associated to both exposure and outcomes, or to outcomes only) were decided a priori to get the optimized propensity score model to reduce bias.[38] Art-active and passive arts engagement groups were matched with the control group on the logit of the propensity score, with calipers widths equal to 0.2 of the standard deviation.[39] The Stata 'psmatch2' module was adopted to conduct the nearest neighbor matching technique without replacement, and the model's ability to balance the cohorts was tested using standardized differences.[40] Successful matching was indicated BMJ the absolute standardized mean difference after matching was less than 0.25.[41] A matching ratio of 1:2 was used for active arts engagement (to get more appropriate comparators as the proportion of active arts engagement was smaller) and 1:1 was used for passive arts engagement. Model sensitivity was assessed by the Rosenbaum Bounds for Hodges-Lehmann Point

Estimate which evaluated the robustness of findings to hidden biases as a result of unobserved covariates. The maximum Gamma (odds of differential assignment to treatment due to unobserved factors) was set to two, and increments of 0.1 were made to identify a point where the between-group differences were no longer robust.[42] Subsequent analyses were conducted to estimate the impact of active or passive arts engagement with the matched samples using appropriate methods. Independent t-tests were used to assess the impact of active or passive art on wellbeing on participants, and effect size (*d*) was also reported between the treated and control group. All statistical analyses were performed by Stata for Windows, Version 14.2 (StataCorp, Texas, USA). A two-sided p-value of less than 0.05 was considered statistically significant.

RESULTS

Study participants' age ranged from 50 – 95 years (M=64.2, SD=10.0), with 45% males and 81% of Chinese ethnicity, of which were representative of Singapore's older population. 60% of participants reported attending at least one arts and culture activity within a time frame of six months (i.e. passive arts engagements), while 17% of the respondents reported actively participating in at least one arts and culture event within a timeframe of three months (i.e. active arts engagements). Overall, participants spent a median time of 6 hours attending arts events (IQR=11.0; range=0–258 hours) within a six-month time period, and a median time of 11 hours actively engaged in the arts (IQR=27.6; range=0–1015 hours) within a three-month time period. Top reported art forms among passive arts attendees in this sample included film (28%), heritage-related events (23%) and theatre (25%). As for active arts participants, engagements in visual arts (5%), music (4%) and craftwork (4%) were commonly reported. Detailed demographic information, physical activity levels and scores of all outcome variables are reported in table 1. For subsequent analysis, four outliers were identified and removed due to overtly high arts engagement hours (who may be professional artists or art enthusiasts), hence data from 1,063 participants were used for subsequent analyses. There were no missing data for the variables in this study.

Results from the correlational analyses indicated that passive arts engagement was associated with better wellbeing measures, specifically, quality of life (r=0.233, p<0.0001), perceived health (r=0.174, p<0.0001), social functioning (r=0.106, p=0.001), mental health (r=0.124, p<0.0001), spiritual wellbeing (r=0.162, p<0.0001) and interpersonal support (r=0.172, p<0.0001). Furthermore, active engagements in the arts were associated with better quality of life (r=0.177, p<0.0001), health perceptions (r=0.130, p<0.0001), role functioning (r=0.078, p=0.011), social functioning (r=0.100, p=0.001) and mental health (r=0.154, p<0.0001), as well as enhanced spiritual wellbeing (r=0.201, p<0.0001) and interpersonal support (r=0.116, p<0.0001). After adjusting for covariates in each model, findings from exploratory regression analyses indicated that passive engagement in the arts was a significant independent predictor of better quality of life (β=0.166, SE=0.008, p<0.0001), health perceptions (β=0.146, SE=0.035, p<0.0001), mental health (β=0.095, SE=0.028, p=0.002), spiritual wellbeing (β=0.128, SE=0.014, p<0.0001) and interpersonal support (β=0.101, SE=0.012, p=0.0003). Similarly, active engagement in the arts were also a significant predictor of quality of life (β=0.139, SE=0.006, p<0.0001), health perceptions (β=0.078, SE=0.026 p=0.006) and spiritual wellbeing (β=0.065, SE=0.011, p=0.023). Please refer to table 2 for more details regarding the exploratory correlational and regression analyses.

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Table 1. Characteristics of Respondents

Demographic Characteristic	N (%)	Variable Information	N (%) / Mean (SD)
Demographic Background		**Arts Engagement Frequency (n, %)**	
Gender		Active Arts Engagement	178 (16.7)
Male	479 (44.9)	Top reported: Visual Art	49 (4.6)
Female	588 (55.1)	Top reported: Music	43 (4.0)
Age at time of survey (years)		Top reported:Craftwork	41 (3.8)
50 - 59	421 (39.5)	Passive Arts Engagement	645 (60.4)
60 - 69	372 (34.9)	Top reported: Film	295 (27.6)
>70	274 (25.7)	Top reported: Theatre	270 (25.3)
Marital Status		Top reported: Heritage-related events	244 (22.9)
Single/Divorced/Widowed	216 (20.2)	**Physical Activity Levels (Mean, SD)**	
Married	851 (79.8)	Light Intensity (Range: 0–57)	5.3 (9.3)
Ethnicity		Moderate Intensity (Range: 0–60)	2.0 (6.1)
Chinese	859 (80.5)	Vigorous Intensity (Range: 0–10)	0.3 (1.0)
Malay	121 (11.3)	Strength and Balance (Range: 0–30)	0.7 (1.5)
Indian	78 (7.3)	Overall Physical Activity (Range: 0–87)	8.2 (12.4)
Others (E.g. Eurasian)	9 (0.8)	**Wellbeing Variables (Mean, SD)**	
Highest Obtained Education		Quality of Life (WHOQOL-8)[b] (Range: 11–40)	31.4 (4.2)
Up to Primary/Elementary School	678 (63.5)	SF20[c] - Health Perception (Range: 0–100)	69.9 (19.6)
Secondary/High School or Above	389 (36.5)	SF20 - Pain (Range: 0–80)	17.4 (20.0)
Employment Status		SF20 - Social Functioning (Range: 0–100)	90.8 (21.4)
Full-time / Self-employed	309 (29.0)	SF20 - Role Functioning (Range: 0–100)	87.9 (29.3)
Part-time employed	148 (13.9)	SF20 - Physical Functioning (Range: 0–100)	86.1 (23.0)
Unemployed or Retired	610 (57.2)	SF20 - Mental Health (Range: 0–100)	81.9 (14.7)
Monthly Household Income (SGD)[a]		Interpersonal Support (ISEL-S)[d] (Range: 12–48)	37.8 (6.6)
< 2,000	412 (38.6)	Appraisal Support Subscale (Range: 4–16)	12.7 (2.4)
2,000 - 3,999	335 (31.4)	Belonging Support Subscale (Range: 4–16)	12.3 (2.6)
≥ 4,000	320 (30.0)	Tangible Support Subscale (Range: 4–16)	12.9 (2.3)
Housing Type		Spiritual Wellbeing (FACIT-Sp-12)[e] (Range: 7–48)	34.0 (8.0)
1 / 2 / 3-room flat	308 (28.9)	Meaning Subscale (Range: 1–16)	12.4 (2.9)
4-room flat	378 (35.4)	Peace Subscale (Range: 2–16)	12.3 (2.8)
5-room/ 3-Gen/ Executive/ Mansionette	277 (26.0)	Faith Subscale (Range: 0–16)	9.3 (3.8)
Condominium and Others	104 (9.7)		
Living Arrangements			
Family (e.g. Spouse, Children, Siblings)	968 (90.7)		
Living alone	71 (6.7)		
Others (e.g. Friends, Tenants)	28 (2.6)		

[a] *SGD: Singapore Dollar,* [b]*WHOQOL-8: World Health Organization Quality of Life Instrument (8-item) ,* [c] *SF20: 20-Item Short Form Survey,* [d] *ISEL-S: Interpersonal Support Evaluation List – Short Form;* [e] *FACIT-Sp-12: Functional Assessment of Chronic Illness Therapy - Spiritual Well-Being; The 12-item Spiritual Well-Being Scale*

Table 2. Spearman Correlations and Multiple Regression Analyses Predicting Wellbeing

Wellbeing Measures	Passive Arts Engagement						Active Arts Engagement					
	Spearman Correlation		Multiple Regression				Spearman Correlation		Multiple Regression			
	r	p value	β	SE	p value	Adj. R^2	r	p value	β	SE	p value	Adj. R^2
Quality of Life (WHOQOL-8)	0.233	<0.0001*	0.166	0.008	<0.0001*	0.150	0.177	<0.0001*	0.139	0.006	<0.0001*	0.142
Holistic Health (SF20)												
SF20 - Health Perception	0.174	<0.0001*	0.146	0.035	<0.0001*	0.179	0.130	<0.0001*	0.078	0.026	0.006*	0.163
SF20 - Role Functioning	0.050	0.101	…	…	…	…	0.078	0.011*	…	…	…	…
SF20 - Pain Domain	-0.010	0.750	…	…	…	…	-0.024	0.430	…	…	…	…
SF20 - Social Functioning	0.106	0.0001*	…	…	…	…	0.100	0.0001*	…	…	…	…
SF20 - Physical Function	0.050	0.103	…	…	…	…	0.027	0.373	…	…	…	…
SF20 - Mental Health	0.124	<0.0001*	0.095	0.028	0.002*	0.069	0.154	<0.0001*	0.057	0.021	0.058	0.063
Spiritual Wellbeing (FACIT-SP-12)	0.162	<0.0001*	0.128	0.014	<0.0001*	0.177	0.201	<0.0001*	0.065	0.011	0.023*	0.164
Meaning Subscale	0.164	<0.0001*	0.121	0.005	<0.0001*	0.191	0.244	<0.0001*	0.081	0.004	0.004*	0.183
Peace Subscale	0.153	<0.0001*	0.123	0.005	<0.0001*	0.144	0.205	<0.0001*	0.094	0.004	0.001*	0.138
Faith Subscale	0.096	0.002*	0.084	0.007	0.003*	0.171	0.095	0.002*	0.004	0.005	0.896	0.164
Interpersonal Support (ISEL-S)	0.172	<0.0001*	0.101	0.012	0.0003*	0.180	0.116	<0.0001*	0.036	0.009	0.205	0.172
Appraisal Subscale	0.126	<0.0001*	0.086	0.004	0.003*	0.133	0.096	0.002*	0.030	0.003	0.299	0.127
Belonging Subscale	0.190	<0.0001*	0.123	0.005	<0.0001*	0.163	0.117	<0.0001*	0.043	0.003	0.134	0.150
Tangible Subscale	0.135	<0.0001*	0.059	0.004	0.039*	0.144	0.106	0.001*	0.022	0.003	0.439	0.141

*N= 1063, *p<0.05, Note: Variables which satisfied the normality tests are reported in the table; Covariates entered: age, gender, marital status, number of children, education, presence of religious belief, employment status, monthly household income, housing type, presence of chronic illness*

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Balancing information before and after propensity score matching is presented in the table 3. After matching, a total of 444 (treatment = 176 & control = 268) cohort participants were included in the analysis for active group and 730 (treatment = 365 & control = 365) were included in the analysis for passive group respectively. All included covariates achieved balance after matching in the PSM analysis except for age and some physical activity components, however these differences were minimal. For the active engagement group, the median bias prior to matching was 22.8% and that was reduced to 1.4% after matching. The median bias prior to matching for the passive engagement group was 15.1% and was reduced to 8.6% after matching. The unmatched units were dropped as the propensity score model did not find any appropriate control with respect to the case. The characteristics of matching variables between matched and unmatched samples in both active and passive engagement groups were further compared. Descriptive analysis showed that propensity score model clearly distinguished the samples with similar characteristics in matched group compared with the unmatched group (see supplementary Table S1). Model sensitivity analysis showed these results were acceptable and robust as Gamma value did not include zero in the lower and upper bounds when it increased to two.

Detailed findings of the t-tests conducted are presented in table 4. Results from independent-samples t-tests revealed that participants who engaged in the arts scored significantly better in multiple measures of wellbeing. For the passive engagement group, participants reported a significantly higher quality of life [t(728)=3.35, p=0.0008, d=0.25] and perceived health scores [t(728)=2.21, p=0.0277, d=0.16] than matched controls. Although there were no significant differences in overall social wellbeing, arts attendees reported an enhanced sense of belonging [t(728)=2.17, p=0.03, d=0.16] in the social wellbeing subscale than non-arts attendees. Independent-sample t-tests conducted with the active arts engagement group also revealed significant mean differences in quality of life [t(442)=3.68, p=0.0003, d=0.36], perceived health [t(442)=2.59, p=0.0099, d=0.25] and overall spiritual wellbeing [t(442)=3.75, p=0.0002, d=0.37]. Moreover, participants who actively participated in the arts also reported greater spiritual wellbeing subscale scores in meaning in life [t(442)=5.02, p<0.0001, d=0.50] as well as sense of peace [t(442)=3.72, p=0.0002, d=0.36] in comparison to matched controls. Finally, although marginally significant, active arts participants also reported better social functioning [t(442)=1.68, p=0.0939, d=0.17] and mental health [t(442)=1.84, p=0.0668, d=0.18].

Table 3. Distribution of Balance for Covariates Before and After Matching by Propensity Score Matching (PSM) in Passive and Active Engagement Groups

Balance variables	Passive Engagement						Active Engagement					
	Before matching (n = 1063)			After matching (n = 730)			Before matching (n = 1063)			After matching (n = 444)		
	Passive Group (n = 642)	Non- Passive Group (n = 421)	Standardized Difference[†]	Passive Group (n = 365)	Non-Passive Group (n = 365)	Standardized Difference[†]	Active Group (n = 176)	Non-Active Group (n =887)	Standardized Difference[†]	Active Group (n = 176)	Non-Active Group (n =268)	Standardized Difference[†]
Age (years)	62.57	66.73	0.41	66.47	65.02	-0.15	61.60	64.74	0.34	61.60	61.63	0.004
Sex												
Male respondents	0.42	0.49	0.13	0.52	0.47	-0.09	0.38	0.46	0.18	0.38	0.37	0.01
Marital Status												
Married	0.81	0.77	-0.10	0.77	0.79	0.05	0.86	0.79	0.19	0.86	0.84	-0.06
Highest Obtained Education												
Elementary school	0.49	0.56	0.13	0.64	0.58	-0.12	0.43	0.54	0.22	0.43	0.48	0.11
High School or Higher	0.43	0.27	-0.33	0.23	0.31	0.18	0.53	0.33	-0.42	0.53	0.47	-0.14
Ethnicity												
Chinese ethnic group	0.81	0.79	-0.06	0.78	0.80	0.05	0.84	0.80	0.09	0.84	0.85	0.03
Religious Belief												
Have religious belief	0.88	0.86	-0.05	0.86	0.86	0.02	0.88	0.87	0.02	0.88	0.88	0.02
Employment Status												
Part-time employed	0.16	0.11	-0.14	0.10	0.13	0.09	0.20	0.13	-0.22	0.20	0.19	-0.05
Full-time or self-employed	0.32	0.25	-0.15	0.25	0.27	0.04	0.32	0.29	-0.07	0.32	0.31	-0.02
Monthly Household Income (SGD)												
1,000 - 2,999	0.29	0.32	0.06	0.36	0.32	-0.08	0.24	0.31	0.17	0.24	0.27	0.08
>3,000	0.51	0.39	-0.25	0.37	0.42	0.11	0.54	0.45	-0.19	0.54	0.51	-0.07
Housing Type												
3-4 room HDB Flat	0.55	0.62	0.12	0.65	0.62	-0.06	0.47	0.60	0.27	0.47	0.50	0.07
5 room HDB Flat and others	0.38	0.31	-0.15	0.28	0.32	0.10	0.49	0.33	-0.34	0.49	0.45	-0.09
Physical Activity Levels (Hours)												
Light Intensity	6.49	3.43	-0.35	2.52	3.69	0.21	9.09	4.52	-0.42	9.09	7.23	-0.16
Moderate Intensity	2.46	1.42	-0.18	1.02	1.59	0.13	3.30	1.80	-0.24	3.30	3.27	-0.004
Vigorous Intensity	0.32	0.16	-0.17	0.11	0.16	0.09	0.51	0.20	-0.24	0.51	0.36	-0.11
Strength and Balance	0.78	0.51	-0.19	0.46	0.56	0.13	1.00	0.61	-0.23	1.00	0.72	-0.18
All Physical Activities	10.05	5.52	-0.39	4.11	6.01	0.25	13.91	7.13	-0.48	13.91	11.57	-0.15

[†]Standardized difference = difference in means or proportions divided by standard error are shown; balance defined as absolute value less than 0.25 (small effect size).

Table 4. Group Differences in Wellbeing Scores

Wellbeing	Passive Arts Engagement[a]					Active Arts Engagement[b]				
	Passive (Mean ± SD)	Control (Mean ± SD)	t(728)	p	Effect Size(d)	Active (Mean ± SD)	Control (Mean ± SD)	t(442)	p	Effect Size(d)
Quality of Life (WHOQOL-8)	31.5 ± 4.15	30.5 ± 4.2	3.35	0.0008*	0.25	33.0 ± 4.16	31.5 ± 4.14	3.68	0.0003*	0.36
Short Form Health Survey (SF-20)										
SF20 - Health Perception	69.6 ± 19.9	66.3 ± 21.1	2.21	0.028*	0.16	75.5 ± 18.2	70.7 ± 19.3	2.59	0.0099*	0.25
SF20 - Role Functioning	85.4 ± 31.2	86.4 ± 31.7	0.44	0.659	0.03	92.8 ± 24.2	91.1 ± 26.1	0.66	0.512	0.06
SF20 - Pain Domain	18.1 ± 20.9	17.8 ± 20.7	0.18	0.859	0.01	16.7 ± 20.6	17.9 ± 19.6	0.62	0.538	0.06
SF20 - Social Functioning	90.9 ± 19.6	88.9 ± 24.5	1.20	0.230	0.09	95.6 ± 14.7	92.8 ± 18.7	1.68	0.094	0.17
SF20 - Physical Function	84.9 ± 22.2	84.4 ± 25.2	0.27	0.785	0.02	89.2 ± 18.6	88.5 ± 20.9	0.37	0.715	0.04
SF20 - Mental Health	81.2 ± 14.8	80.5 ± 15.4	0.63	0.532	0.05	86.0 ± 13.1	83.6 ± 14.0	1.84	0.067	0.18
Interpersonal Support (ISEL-S)	37.4 ± 6.3	36.8 ± 6.4	1.14	0.253	0.08	39.4 ± 6.9	38.7 ± 6.4	1.10	0.273	0.11
Appraisal Subscale	12.4 ± 2.3	12.4 ± 2.4	0.32	0.751	0.02	13.1 ± 2.6	12.9 ± 2.4	0.70	0.483	0.07
Belonging Subscale	12.2 ± 2.5	11.8 ± 2.6	2.17	0.030*	0.16	12.9 ± 2.6	12.6 ± 2.4	1.16	0.246	0.11
Tangible Subscale	12.7 ± 2.2	12.6 ± 2.3	0.44	0.658	0.03	13.4 ± 2.5	13.1 ± 2.2	1.12	0.262	0.11
Spiritual Wellbeing (FACIT-Sp-12)	33.5 ± 8.0	33.1 ± 8.1	0.68	0.496	0.05	37.5 ± 7.2	34.7 ± 7.7	3.75	0.0002*	0.37
Meaning Subscale	12.2 ± 2.8	12.1 ± 3.0	0.12	0.908	0.01	13.9 ± 2.3	12.6 ± 2.8	5.03	<0.0001*	0.50
Peace Subscale	12.1 ± 2.7	11.9 ± 3.0	0.81	0.419	0.06	13.5 ± 2.6	12.5 ± 2.7	3.72	0.0002*	0.36
Faith Subscale	9.3 ± 3.9	9.0 ± 3.9	0.73	0.464	0.05	10.1 ± 4.0	9.6 ± 3.8	1.25	0.211	0.12

[a]n = 730, [b]n = 444; *p<0.05

DISCUSSION

This was the first-ever empirical research that examined arts engagements and its impact on holistic wellbeing among current and future elderly populations in Asia using naturalistic observational data with PSM analysis. This study established significantly strong causal relationships between arts engagements (both passive and active engagements) and numerous domains of holistic wellbeing in a naturalistic sample of older adults in Singapore. The results revealed that by passively engaging in the arts, older adults experienced significantly higher quality of life, better perceived health and greater social connectedness as compared to non-art attendees. The results further showed that older adults who actively engaged in the arts experienced significantly enhanced quality of life, better perceived health, stronger spiritual wellness, life meaning and peace with a medium effect size, as compared to non-art participants. These findings support that varying depths of arts engagements could impact different domains of holistic wellness among older adults, where both passive exposures to and active engagements in the arts could bring about quality of life and subjective health benefits.

The findings from this study also supported past literature, [43-45] and provided novel contributions to the growing research on arts, health and wellness. Firstly, the present study adopted a holistic view and assessed multiple domains of wellbeing including quality of life, perceived health and mental health, social support and spiritual wellness, whereas past studies only examined the effects of the arts on one or a very selected few facets of wellbeing.[10,11,43-45] Secondly, the present study included an extensive range of art forms with specific cultural genres (e.g. 'angklung' – bamboo flute, 'wayang kulit' – shadow puppets, and Chinese operas) to investigate its effects on health and wellness among a specific cohort of current and soon-to-be older adults between the ages of 50 and 95, as well as employed a stratified random survey method to recruit a sizable sample that was highly representative of Singapore's elderly population. Thus, the results generated had strong generalizability to local populations and provided policy makers, practitioners and researchers with age and cultural-specific insights on programme development.[46] The results could also serve as a frame of reference for the advancement of other Asian societies that share similar socio-cultural demographics and structures such as Hong Kong, Malaysia and other major cities in China. Finally, through propensity score matching, participants engaged in the arts were systematically matched on multiple covariates with respondents who did not engage in the arts. This allowed for meaningful comparisons between groups in a naturalistic sample, of which is greatly lacking in the literature on arts, health and wellness. To our knowledge, this is the first arts and health study that employed this analytical method.

One can connect to literature on creativity, self-mastery, relational aesthetics and neurological sciences for the inner workings of arts and wellness. Arts engagement fosters an empowering process of creativity and autonomy that cultivates mindful-awareness, self-understanding and new insights.[47] This in turn facilitates motivation for narrative identity processing,[48] a constructive reflection process of character building that fosters life meaning and self-affirmation, leading to the development of self-mastery.[49,50] Through arts engagements, individuals would also encounter relational aesthetics, an experience of emotional connections via metaphoric dialogue with the arts and the artists that broadens perspectives and nurtures diversity, while inspiring human connections, empathy and compassionate citizenry.[51,52] Arts engagement may also have a role to play in stimulating the parasympathetic nervous system, leading to a greater sense of peace and relaxation.[53] Finally, neurological literature has illustrated the effects of arts as a means for stimulating

neuroplasticity and building cognitive reserve.[54,55] As such, it is evident that the arts can positively impact various domains of wellbeing through numerous psychosocial processes, particularly for older adults whose sense of identity and personhood progressively decline with the onset of old age, worsening health and diminishing social networks.[56]

Future arts-based elderly care programmes may target these avenues and pathways for wellness promotion. The findings show that attending art events could reap social and relational benefits for tackling social isolation, while creating art could harness intrinsic benefits that lead to spiritual fulfillment and growth. From a policy perspective, this translates into multiple entry points for attracting and maintaining arts participation among older populations. Thus, considerations for a formal and sustainable structure that incorporates participatory art initiatives and programmes into aged care services, while ensuring proficient training of more community art workers to support these works could be made as this would be a cost-effective way to promote healthy, creative and meaningful ageing. Despite the positive effects of creative arts engagement on health, it has been repeatedly found that promoting engagement in the arts among the elderly is difficult, as participation in the arts generally declines with age, most progressively among individuals reaching age of 65, and most markedly for those aged 75 and above.[57] Similar findings have also been reported in Singapore, where older adults aged 60 and above had the lowest art attendance and art participation rates among all age cohorts.[58] Within this sample, art participation rates among adults aged 50 and above was 17%. This trend is disconcerting given the fact that the arts could play a significant role in supporting well-being in old age. From a practice perspective, participatory arts programmes and initiatives could include public education and advocacy campaigns to promote arts engagements, art-based psychosocial care programming designed for community and residential care settings, as well as collaboration with arts and cultural heritage intuitions in developing arts programmes that are fitting to the needs and interests of older adults. Practitioners and health care providers could consider the arts as a non-medical, non-pharmaceutical agent for mental health and quality of life enhancement, and may also consider integrating passive art activities to enhance social programmes for older adults. Finally, the arts may also be considered as a gateway to support stronger social networks for tackling the public health problem of loneliness through programmes that use the arts as platforms for outreach, relational bonding and community building.

The results of this study, although theoretically and practically appealing, were not without its limitations. Firstly, potential confounders were balanced in the PSM except for age and frequency of light intensity physical activity, hence caution must be exercised when interpreting the results. Moreover, despite having model sensitivity analyses conducted for unobserved covariates, the presence of other potential confounding variables in this study such as the presence competing social activities, recreational and religious activities, as well as living arrangements should be assessed and controlled for in future research. Secondly, the arts engagement assessment items required the accuracy of memory recall (three to six months prior to data collection) from the participants and the psychometric measures were self-reported. Future research could consider administering objective measures of arts engagement such as clinical observations and activity journals, as well as health service utilization and functional magnetic resonance imaging (fMRI) to assess the objective health and wellbeing outcomes. Finally, the current study employed cross-sectional survey data that assessed participants at a single time point, and thus was not possible to rule out the potentiality of reverse

causality. For example, while our findings reveal that art attendance enhances one's sense of belonging, the opposite may hold true where a sense of belonging could be a precursor to art attendance, implying that programme design and implementation would need to target both enablers, namely to facilitate belonging and making art appealing. In order to obtain a deeper understanding of the causal and directional effects of arts engagement, future studies should consider implementing a robust experimental or longitudinal research design. Despite these limitations, the findings generated from this study are important starting points for future empirical research in Singapore and neighboring regions, as they provide a critical cross-cultural understanding on the relationship between arts and wellness in greater Asia, while contributing to the growing literature on the subject matter internationally.

In conclusion, the arts can play a significant role in sustaining a healthy, active and resilient elderly populace with greater cost-efficiency than traditional medicine and health service models. Under the rubric of rapid population ageing, the need for more evidence-driven arts promotion initiatives to foster active and creative ageing, as well as greater art-based psychosocial care for the elderly is urgently warranted in Asia and around the globe.

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AUTHOR CONTRIBUTIONS

In terms of author contributions, AHYH, MHRH, JSP and EO designed the study and obtained funding, SHXM carried out literature search and data collection, RCB carried out data analysis, all authors contributed to data interpretation, as well as the writing and revision of the manuscript.

COMPETING INTERESTS

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DATA AVAILABILITY STATEMENT

No additional data available.

EXCLUSIVE LICENCE

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Table S1: Comparison of background variables between matched and unmatched samples in active and passive engagement groups

Variables	Active engagement			Passive engagement		
	Unmatched (n = 619)	Matched (n = 444)	P-value	Unmatched (n = 333)	Matched (n = 730)	P-value
Age (years)	66.4 ± 10.6	61.2 ± 8.3	<0.001	66.4 ± 11.1	63.2 ± 9.4	<0.001
Sex			<0.001			0.173
Male	308 (49.8)	170 (38.3)		160 (48.1)	318 (43.6)	
Female	311 (50.2)	274 (61.7)		173 (51.9)	412 (56.4)	
Marital Status			0.001			0.037
Single	147 (23.7)	68 (15.3)		80 (24.0)	135 (18.5)	
Married	472 (76.3)	376 (84.7)		253 (76.0)	595 (81.5)	
Educational status			<0.001			<0.001
No Formal Education	110 (17.8)	15 (3.4)		57 (17.1)	68 (9.3)	
Elementary school	341 (55.1)	210 (47.3)		176 (52.9)	375 (51.4)	
High school or Higher	168 (27.1)	219 (49.3)		100 (30.0)	287 (39.3)	
Ethnicity			0.010			0.758
Non-Chinese	137 (22.1)	70 (15.8)		63 (18.9)	144 (19.7)	
Chinese	482 (77.9)	374 (84.2)		270 (81.1)	586 (80.3)	
Religious belief			0.351			0.498
No religious belief	86 (13.9)	53 (11.9)		47 (14.1)	92 (12.6)	
Have a religious belief	533 (86.1)	391 (88.1)		286 (85.9)	638 (87.4)	
Employment status			<0.001			0.009
Unemployed/retired	388 (62.6)	219 (49.3)		213 (64.0)	394 (54.0)	
Part time employment	61 (9.9)	86 (19.4)		39 (11.7)	108 (14.8)	
Full time/ self-employed	170 (27.5)	139 (31.3)		81 (24.3)	228 (31.2)	
Monthly household income (SGD)			0.001			0.004
<1,000	164 (26.5)	86 (19.4)		96 (28.8)	154 (21.1)	
1,000 - 2,999	197 (31.8)	124 (27.9)		106 (31.8)	215 (29.5)	
>3,000	258 (41.7)	234 (52.7)		131 (39.4)	361 (49.4)	
Housing type			<0.001			0.099
1-2 room HDB flat	55 (8.9)	14 (3.2)		29 (8.7)	40 (5.5)	
3-4 room HDB flat	389 (62.8)	226 (50.9)		194 (58.3)	421 (57.7)	
5 room HDB flat and others	175 (28.3)	204 (45.9)		110 (33.0)	269 (36.8)	
Physical activity level (hours)						
Light intensity (mean ± s.d.)	4.1 ± 7.4	6.9 ± 11.3	0.0002	4.6 ± 9.4	5.6 ± 9.3	0.023
Moderate intensity (mean ± s.d.)	1.7 ± 5.7	2.5 ± 6.6	0.0001	1.6 ± 5.2	2.2 ± 6.5	0.005
Vigorous intensity (mean ± s.d.)	0.2 ± 0.8	0.3 ± 1.2	0.015	0.2 ± 0.9	0.3 ± 1.0	0.009
Strength and balance (mean ± s.d.)	0.6 ± 1.6	0.8 ± 1.4	0.010	0.6 ± 1.9	0.7 ± 1.3	0.105
All physical activity (mean ± s.d.)	6.6 ± 10.6	10.5 ± 14.4	<0.001	7.1 ± 12.1	8.8 ± 12.6	0.0002

The Arts for Ageing Well: A Propensity Score Matching Analysis of the Effects of Arts Engagements on Holistic Wellbeing among Older Asian Adults above 50 years of age

Last Update: 22 Aug 2019

STROBE Statement—Checklist of items that should be included in reports of *cross-sectional studies*

	Item No	Recommendation	Reported on Manuscript Page (Section)
Title and abstract	1	(*a*) Indicate the study's design with a commonly used term in the title or the abstract	1 (Title)
		(*b*) Provide in the abstract an informative and balanced summary of what was done and what was found	2 (Abstract)
Introduction			
Background/rationale	2	Explain the scientific background and rationale for the investigation being reported	3,4 (Introduction)
Objectives	3	State specific objectives, including any prespecified hypotheses	4 (Research Objectives)
Methods			
Study design	4	Present key elements of study design early in the paper	5 (Study Design and Participants)
Setting	5	Describe the setting, locations, and relevant dates, including periods of recruitment, exposure, follow-up, and data collection	5 (Study Design and Participants)
Participants	6	(*a*) Give the eligibility criteria, and the sources and methods of selection of participants	5 (Study Design and Participants)
Variables	7	Clearly define all outcomes, exposures, predictors, potential confounders, and effect modifiers. Give diagnostic criteria, if applicable	5 (Study variables)
Data sources/ measurement	8*	For each variable of interest, give sources of data and details of methods of assessment (measurement). Describe comparability of assessment methods if there is more than one group	6 (Study variables)
Bias	9	Describe any efforts to address potential sources of bias	7,8 (Statistical Analysis)
Study size	10	Explain how the study size was arrived at	4 (Study Design and Participants)
Quantitative variables	11	Explain how quantitative variables were handled in the analyses. If applicable, describe which groupings were chosen and why	7 (Statistical Analysis)
Statistical methods	12	(*a*) Describe all statistical methods, including those used to control for confounding	7,8 (Statistical Analysis)
		(*b*) Describe any methods used to examine subgroups and interactions	7,8 (Statistical Analysis)
		(*c*) Explain how missing data were addressed	8 (Results)
		(*d*) If applicable, describe analytical methods taking account of sampling strategy	5 (Study Design and Participants)
		(*e*) Describe any sensitivity analyses	8 (Methods) 11 (Results)

The Arts for Ageing Well: A Propensity Score Matching Analysis of the Effects of Arts Engagements on Holistic Wellbeing among Older Asian Adults above 50 years of age

Results			
Participants	13*	(a) Report numbers of individuals at each stage of study—eg numbers potentially eligible, examined for eligibility, confirmed eligible, included in the study, completing follow-up, and analysed	5 (Methods; Procedures)
		(b) Give reasons for non-participation at each stage	5 (Methods; Procedures)
		(c) Consider use of a flow diagram	N.A.
Descriptive data	14*	(a) Give characteristics of study participants (eg demographic, clinical, social) and information on exposures and potential confounders	8 (Results), 9 (Table 1)
		(b) Indicate number of participants with missing data for each variable of interest	8 (Results)
Outcome data	15*	Report numbers of outcome events or summary measures	8 (Results), 9 (Table 1)
Main results	16	(*a*) Give unadjusted estimates and, if applicable, confounder-adjusted estimates and their precision (eg, 95% confidence interval). Make clear which confounders were adjusted for and why they were included	12 (Table 3)
		(*b*) Report category boundaries when continuous variables were categorized	N.A.
		(*c*) If relevant, consider translating estimates of relative risk into absolute risk for a meaningful time period	N.A.
Other analyses	17	Report other analyses done—eg analyses of subgroups and interactions, and sensitivity analyses	8 (Methods) 10 (Results)
Discussion			
Key results	18	Summarise key results with reference to study objectives	14 (Discussion)
Limitations	19	Discuss limitations of the study, taking into account sources of potential bias or imprecision. Discuss both direction and magnitude of any potential bias	15 (Discussion)
Interpretation	20	Give a cautious overall interpretation of results considering objectives, limitations, multiplicity of analyses, results from similar studies, and other relevant evidence	14, 15 (Discussion)
Generalizability	21	Discuss the generalizability (external validity) of the study results	14, 15 (Discussion)
Other information			
Funding	22	Give the source of funding and the role of the funders for the present study and, if applicable, for the original study on which the present article is based	16 (Role of the Funding Source)

*Give information separately for exposed and unexposed groups.

The Arts for Ageing Well: A Propensity Score Matching Analysis of the Effects of Arts Engagements on Holistic Wellbeing among Older Asian Adults above 50 years of age

Note: An Explanation and Elaboration article discusses each checklist item and gives methodological background and published examples of transparent reporting. The STROBE checklist is best used in conjunction with this article (freely available on the Web sites of PLoS Medicine at http://www.plosmedicine.org/, Annals of Internal Medicine at http://www.annals.org/, and Epidemiology at http://www.epidem.com/). Information on the STROBE Initiative is available at www.strobe-statement.org.