A systematic review of physical activity and quality of life and well-being

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Abstract
Maintaining or improving quality of life (QoL) and well-being is a universal goal across the lifespan. Being physically active has been suggested as one way to enhance QoL and well-being. In this systematic review, conducted in part for the 2018 U.S. Health and Human Services Physical Activity Guidelines for Americans Scientific Advisory Committee Report, we examined the relationship between physical activity (PA) and QoL and well-being experienced by the general population across the lifespan and by persons with psychiatric and neurologic conditions. Systematic reviews, meta-analyses, and pooled analyses from 2006 to 2018 were used for the evidence base. Strong evidence (predominantly from randomized controlled trials [RCTs]) demonstrated that, for adults aged 18–65 years and older adults (primarily 65 years and older), PA improves QoL and well-being when compared with minimal or no-treatment controls. Moderate evidence indicated that PA improves QoL and well-being in individuals with schizophrenia and Parkinson’s disease, and limited evidence indicated that PA improves QoL and well-being for youth and for adults with major clinical depression or bipolar disorder. Insufficient evidence existed for individuals with dementia because of a small number of studies with mixed results. Future high-quality research designs should include RCTs involving longer interventions testing different modes and intensities of PA in diverse populations of healthy people and individuals with cognitive (e.g., dementia) and mental health conditions (e.g., schizophrenia) to precisely characterize the effects of different forms of PA on aspects of QoL and well-being.

Keywords
Quality of life, Health-related quality of life, Well-being, Physical activity, Systematic review

INTRODUCTION
The World Health Organization (WHO) definition of health encompasses both the absence of disease and the presence of mental and social well-being [1]. Separate theoretical traditions distinguish between evaluative well-being (e.g., life satisfaction and quality of life [QoL]) and experienced well-being (e.g., happiness and positive affect) [2]. These subjective reports frequently overlap, so an umbrella domain of QoL and well-being has emerged [3]. QoL is a global construct often used interchangeably with subjective well-being [4]. QoL is distinct from mental health symptoms and reflects the presence of positive aspects in one’s life.

QoL has a hierarchical structure, with domain-specific components under the umbrella of overall QoL. One domain typically represents health-related QoL (HRQoL) [5]; this domain is often split further into subdomains of physical HRQoL (e.g., evaluations of physical function) and mental HRQoL (e.g., emotional health). Three separate components of subjective well-being have been identified: positive affect, negative affect, and life satisfaction [6]. The first two components refer to the affective, emotional aspects of the construct; the latter to the cognitive-judgmental aspects [4,6]. Given the variable and expansive conceptualizations of QoL and well-being, the literature reviewed here is comprehensive in nature and focuses on both global QoL and HRQoL, as well as on well-being and its derivatives, such as subjective well-being, positive well-being, or psychological well-being.

Being physically active has been suggested as one way to enhance QoL and well-being. Potential mechanisms of the physical activity (PA) and

Implications
Practice: Researchers, educators, and providers should know that participation in regular physical activity (PA) is likely to improve quality of life (QoL) and well-being in many populations.

Policy: Enrolling samples of sufficient size and diversity to support intervention moderator analyses along with mediator analyses will provide useful information for adapting the interventions to optimize uptake among different subgroups.

Research: Incorporating diverse population subgroups, including diverse racial/ethnic groups and vulnerable and underrepresented population groups will expand the potential for having a broader public health impact in disseminating this research.

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QoL/well-being relationship include PA-induced changes in neurotransmitters of the brain and endogenous opioids that are known to be associated with depression, anxiety, and other mood constructs [7,8]. Others have found that a latent conceptualization of psychological distress (i.e., depression, anxiety, stress, and sleep disturbance) was associated with improvements in well-being/satisfaction with life [9]. Psychological constructs have also been reported to play a mechanistic role. Elavsky et al. [10] reported that increased self-efficacy and positive affect resulting from a PA intervention were significantly associated with greater well-being/satisfaction with life. Research has also shown that personality traits (e.g., neuroticism, extraversion, and agreeableness) may predict well-being/satisfaction with life [11,12]. That said, more work is needed to examine if these are truly causal mechanisms.

The charge of the 2018 Physical Activity Guidelines Advisory Committee (PAGAC) was to review the scientific literature of the relationships between PA and QoL. The PAGAC Brain Health Subcommittee was to focus on the general population and not those with chronic diseases being covered by other PAGAC subcommittees. The exception was that the PAGAC Brain Health Subcommittee was also charged with examining the topic (PA and QoL) in populations with conditions related specifically to the brain (e.g., schizophrenia and depression). Also, PA levels have been shown to decline across the lifespan and, thus, a lifespan approach allowed us to examine whether effects are more consistent at certain points in the lifespan. We describe the results of this review and expand it to incorporate research on the relationships between PA and well-being. By integrating the literature across ages and mental health conditions, we sought to develop a global assessment of three questions: (a) What is the relationship between PA and QoL and well-being? (b) Does a dose–response relationship exist and what is the shape of the relationship? (c) Does the relationship vary by age, sex, race/ethnicity, socioeconomic status, or weight status?

**METHODS**

This paper summarizes evidence from scientific reviews examining the effects of PA on QoL and well-being across the lifespan and the effects of PA on QoL and well-being in individuals with psychiatric conditions (but excludes mental health symptoms as outcomes). QoL among individuals who have a chronic physical condition, such as diabetes or osteoarthritis, was not examined here because it was covered by other subcommittees of the PAGAC (e.g., [13, 14]).

This review followed the methods used to conduct the reviews that informed the 2018 PAGAC Scientific Report [15]. The searches were conducted in electronic databases (PubMed, CINAHL, and Cochrane) and supplemented by additional articles identified by experts. The inclusion criteria were predefined, and studies were considered potentially eligible if they were systematic reviews (SRs), meta-analyses (MAs), or pooled analyses published in English from 2006 to February 2017. The year 2006 was chosen as the earliest year of publication of the reviews reviewed. Although QoL was not included in the 2008 PA Guidelines, we wanted to include studies that would not have been included in the 2008 Guidelines. Studies of PA and well-being or studies published in 2017 or 2018 (i.e., after data extraction for the PAGAC report) are also included as the search was updated for this manuscript. Details of the PAGAC search strategy is available at https://health.gov/paguidelines/second-edition/report/supplementary_material/pdf/Brain_Health_Q2_Quality_of_Life_Evidence_Portfolio.pdf.

Given that the terms QoL and well-being are often used interchangeably, and the 2018 PA Guidelines Scientific Advisory Committee was unable to include well-being in their search, we added it to this review for a more comprehensive paper. For the sake of this review, we used a relatively broad definition of PA to include play and recess activities in children to structured exercise programs for adults and experimental manipulations of acute bouts of exercise. All types and intensities of PA, including free-living activities and play, were included in the search as intervention/exposures as was sedentary behavior. Studies of hospitalized patients or animals were excluded.

Two abstractors independently conducted data abstraction tasks. Abstractors were assigned groups of articles to review in an online database. After both abstractors completed the groups, the pair reviewed their entries, discussed discrepancies, and reached an agreement. When needed, the abstractors included a third team member to discuss the disagreements or to gain clarification. In addition to abstracting key information from SRs, MAs, and pooled analyses, the pair of abstractors independently assessed each existing review’s quality using AMSTAR, a modified version of “A Measurement Tool to Assess Systematic Reviews” (AMSTAR). This was used to assess the methodological quality of SRs and MAs. AMSTAR was an adaptation of AMSTAR that focuses on MAs that examined the effects of exercise training on blood pressure. The training and quality control team made additional revisions to adapt AMSTAR for the Committee (SR, MA, and Pooled Analysis Quality Assessment Using Tailored AMSTAR Instrument). The protocol for this review was registered at PROSPERO #CRD42018096695. Figure 1 shows the search strategy and study selection process.
RESULTS
A total of 87 articles (35 from the original PAGAC report; 52 from the updated search) comprised of 29 MAs and 58 SRs were identified, which examined the effects of randomized controlled trials (RCTs) and prospective longitudinal studies with QoL and well-being outcomes. Data were extracted and bias was assessed independently by two reviewers, with disagreement resolved by discussion or by a third person. The results of the bias assessment can be seen in the Supplementary Appendix. Reviews included results from youth (<18 years; n = 8), adults (n = 31), older adults (n = 25), and nonspecified age and conditions (n = 2), as well as populations with depression or bipolar disorder (n = 4), dementia (n = 5), Parkinson’s disease (n = 5), and schizophrenia (n = 7). We summarized the outcomes of our review with the following “grades”: (a) Not assignable, (b) Limited, (c) Moderate, and (d) Strong (see [15] for an in-depth description and the defining characteristics of these categories). Table 1 presents conclusions on the strength of the evidence in each of the following domains.

OLDER ADULTS
The greatest wealth of evidence for an effect of PA on QoL and well-being was found for older adults. In a review of reviews, Zubala et al. found that despite their heterogeneity, interventions often resulted in sustained increases in PA over the study period, typically at 12 months, and led to improvements in general well-being [16]. In a pooled analysis, participants who were physically active for more than 150 min per week, but then dropped to below 150 min per week from baseline to 6 months, showed an average drop of −11.8 (p < .001) in SF-36 physical function scores. In contrast, those who were physically active for fewer than 150 min per week but then increased to more than 150 min per week from baseline to 6 months showed an average increase of +5.1 in SF-36 physical function scores [17]. Overall, meta-analytic results showed that PA consistently improved QoL in older adults. One MA reported that, collectively, exercise programs (1,317 participants) improved QoL (overall and health-related combined) of older adult participants relative to inactive control groups (Z = 2.23, p = .03) with a pooled standardized mean difference (SMD) of 0.86 (95% confidence interval [CI]: 0.11 to 1.62) [18]. Another MA found an overall positive effect of exercise interventions on mental well-being (standardized effect size = 0.27; CI = 0.14 to 0.40) and concluded that mental well-being in later life is modifiable through exercise and PA [19]. Kelly et al. found improvements for the physical function subscale of the physical function component summary score of the SF-36 (Hedges’ g = 0.41, 95% CI: 0.19 to 0.64, p < .001) [20]. These results appear to be consistent across modes of PA. Modes of PA that involve mental and physical components, such as Yoga, Pilates, Qigong, and Tai Chi, hold great potential for improving QoL in both healthy and chronically ill individuals [21]. An SR of 10 intervention studies on Pilates included four studies showing improvement in PA and QoL, including domains of sensorial abilities, activities, social participation, and intimacy. Furthermore, an MA pooling effects of alternative modes of PA on HRQoL, depression, and activities of daily living showed a large composite positive effect size (Hedges’ g = 0.93;
Two recent MAs found a positive effect of specific modes of PA. One included intervention studies of Nordic Walking, a form of brisk walking utilizing a walking pole. Nordic Walking improved QoL compared with walking without poles ($d = 0.53$) or resistance training ($d = 0.93$) [23]. Another identified 12 RCTs of high methodological quality, totaling 752 participants, and found that Yoga improved HRQoL with a medium effect size ($Hedges' g = 0.51$, 95% CI: 0.25 to 0.76) and improved mental well-being with a small effect ($Hedges' g = 0.38$, 95% CI: 0.15 to 0.62) [24]. Another review suggested that mindful movement (e.g., Yoga, Tai Chi, and walking meditation) may outperform conventional physical exercise with regard to effects on QoL [25]. However, some modes of PA, such as interventions with virtual reality/gaming systems had low-quality ratings and limited the ability to draw conclusion on the effectiveness of such modes of PA [26].

The amount of change in overall and specific components of QoL and well-being varied across studies of older adults. Some reviews showed a wide range in QoL score improvement (17.1%–178%) and found that only some SF-36 subscales improved (i.e., physical functioning, role limitations due to physical health or emotional problems, pain, general health, and vitality [energy/fatigue]) [27]. Raymond [28] found improved HRQoL in four of these subscales among the six it examined (physical functioning, role limitations due to physical health or emotional problems, vitality, social functioning, and mental health [emotional well-being]; $p$ range <.001 to .04). A meta-analytic review by Stevens [29] found significant improvements in vitality (odds ratio [OR] = 4.43, 95% CI: 0.31 to 8.54) and general health (OR = 5.46, 95% CI: 1.69 to 9.24). A meta-analytic review of Yoga studies reported improvements for the composite scores for both the physical health subdomain of the SF-36 (SMD = 0.65 [95% CI: 0.02 to 1.28]) and for the mental health subdomain (SMD = 0.66 [95% CI: 0.10 to 1.22]) in favor of the Yoga intervention [30]. A review of intervention, cross-sectional, and longitudinal studies found that PA was consistently associated with several QoL domains: functional capacity; general QoL; autonomy; past, present, and future activities; death and dying; intimacy; mental health; vitality; and psychological QoL [31].

The effects of PA on QoL and well-being on specific segments of older adults are less clear. One SR that intended to assess the effectiveness of interventions across the transition to retirement was inconclusive because of insufficient evidence [32]. Among frail older adults, one review found no significant difference in QoL in studies that used water exercises, flexibility exercises, Tai Chi, and resistance exercises compared to control groups [33] and others found too few studies to reach conclusions [34–36]. A related SR examined combined interventions that included PA but did not focus on PA. Not surprisingly, it was found that combined dietary and exercise components (compared to exercise alone) led to the greatest improvement in QoL [37]. Another review assessed the effectiveness of psychosocial interventions for the promotion of mental health and prevention of depression among older people, but the effects of exercise specifically on
QoL was not reported [38]. Reviews of multimodal exercise programs in older adults (strengthening exercises, cardiovascular, flexibility, and balance training) found small improvements in QoL [39,40].

In sum, strong evidence demonstrates that, for older adults (older than 50 years; primarily 65 years and older), PA improves HRQoL and well-being when compared with minimal or no-treatment controls.

**ADULTS AGED 18–65 YEARS**

Fewer studies have examined young and midlife adults compared to older adults, but those that have indicated a positive association between PA and QoL and well-being. One MA reported a positive trend for PA on overall QoL \( (n = 7, \text{SMD} = 0.11 \ [95\% \text{CI}: -0.03 \text{ to } 0.24]) \) and positive effects on physical health QoL \( (n = 6, \text{SMD} = 0.22 \ [95\% \text{CI}: 0.07 \text{ to } 0.37]) \) and psychological well-being \( (n = 6, \text{SMD} = 0.21 \ [95\% \text{CI}: 0.06 \text{ to } 0.36]) \) as a result of PA interventions [41]. Another review \( (n = 15: 4 \text{RCTs, 3 cohorts, and 5 cross-sectional studies}) \) allowed the examination of PA exposure and QoL [42]. Three of the four RCTs reported significant improvements in reported QoL for the PA exposure versus control group. All of the cohort studies reported significantly higher QoL among those who were more physically active, and all of the cross-sectional studies reported a positive association between more PA and higher-assessed QoL. A large SR included 58 individual studies, 18 (3 cohort and 15 cross-sectional designs) of which assessed QoL with the SF-36 [43]. Of the three cohort studies, all reported positive associations for mental health and two of the three for physical health and vitality. Of the 15 cross-sectional studies, 13 reported positive associations between PA and the physical health domain and 9 reported positive associations for the mental health domain, with positive associations for subdomains related to vitality (9 studies) and pain (8 studies).

Recent MAs have examined the effects of Pilates, Yoga, or Tai Chi on QoL or well-being. However, some MAs did not examine the effects of PA on QoL or well-being as primary outcomes; thus, quantitative data on QoL or well-being was not presented. In an MA and review of Pilates, Pilates practice yielded positive effects on QoL up to 6 months in RCT results [44]. An MA of 17 RCTs reported a significant increase in psychological well-being in favor of Yoga over no active control groups but not compared to other modes of PA. However, for life satisfaction (emotional well-being), social relationships (social well-being), and mindfulness, no significant effects for Yoga were found across active or nonactive controls [45]. An SR on Sahaja Yoga found similar results such that Sahaja Yoga is also associated with increased subjective well-being and psychological well-being [46]. Another MA compared Yoga with no treatment, but results for QoL were not reported, partially, because the focus was on menopausal symptoms [47]. Walking groups also have an impact on QoL in adults. An MA showed increases in the SF-36 (physical functioning) score of 6.02 (0.51–11.53) [48]. However, the evidence was less clear for other outcomes, such as the SF-36 mental health component, and these studies did not have controls. A more recent MA of group walking found that five of seven trials showed improved scores for group walking versus inactive controls [49].

An MA of Tai Chi interventions found that Tai Chi had a significant effect on general health \( \text{SMD} = -5.08; 95\% \text{ CI}: -7.60, -2.56; p < .0001 \) and vitality \( \text{SMD} = -5.67; 95\% \text{ CI}: -8.54, -2.81; p = .0001 \) of the SF-36 but had no effect on physical function, emotional health, social function, and physical role of the SF-36 [50]. More MAs demonstrated that leisure-time PA (LTPA) is associated with life satisfaction \( (k = 7; n = 2,544; r = .12) \) [51] and that trials showed general improvements in QoL over 6–12 months within PA intervention groups, but there was no consistent benefit of the intervention compared with control conditions [52]. Also, meta-analytical methods have indicated that lower levels of sedentary behaviors were associated with higher physical HRQoL \( \text{estimate of average effect: } r = -.140; 95\% \text{ CI}: -.191, -.088 \) [53].

These positive associations of PA with QoL and well-being from MAs were partly corroborated in reviews of SRs. A review of SRs of Tai Chi studies found fair evidence for increased well-being as a result of participation in Tai Chi but not excellent or good evidence as found for other health outcomes [54]. A review of reviews found that walking programs improved psychological well-being and subjective well-being, although findings varied in effectiveness and the volume of walking required [55].

Other SRs reported similar positive associations between PA and QoL across domains and modes of PA, including LTPA [56], walking [57], gardening [58], Zumba [59], Qigong and related alternative or complementary types of PA [60], and mixtures of aerobic, strength training and alternative or complementary types of PA [61,62]. A review of strength training on psychological outcome measures including QoL reported either comparable effects or no additional benefits to those interventions on QoL [63].

A number of SRs focused on segments of the population, as opposed to the mode of PA. Among office-based workers, PA interventions (exercise, Yoga, and walking) improved well-being across workplace settings compared to no intervention [64]. Inconsistent results with respect to subjective well-being at work were found in a review of the effects of strength training for women on their health in the workplace [65]. Positive effects of PA on well-being were also found for military personnel and veterans. In one review, exercise was found as
one of the nondeployment-related factors positively impacting well-being of military personnel [66], and PA enhanced subjective well-being in combat veterans through active coping [67]. Reviews of perimenopausal or postmenopausal women and women with premenstrual syndrome (PMS) found reductions in symptoms; however, results specific to QoL were not reported [68,69].

Some SRs included PA as one of many health behaviors in interventions, and they appear to have benefits to well-being spanning healthy populations and those with physical or mental health problems [70]; however, the findings specific to the independent effect of PA was not clear. One review found that exercise was more effective than meditation for improving physical HRQoL. That said, the interventions (nonactive forms of meditation vs. exercise) were comparable when evaluating well-being outcomes [71]. In sum, strong evidence demonstrated that, for adults aged 18–65 years, PA improved HRQoL and well-being when compared with minimal or no-treatment controls.

YOUTH

At the time of writing of the PAGAC scientific report, only one review on sedentary behavior and QoL was published in youth. Of the 91 studies included in that review, 15 studies provided information about the relationship between sedentary behavior and QoL among youth aged approximately 9–17 years. Nine of the 12 cross-sectional studies and 2 of the 3 longitudinal studies reported a negative association between sedentary behavior time and QoL [72].

In the updated search of our group that included PA and well-being (vs. QoL only), reviews focused on sedentary behavior and QoL, and well-being in youth were found. A review of screen-based sedentary behavior among adolescent girls reported negative associations between screen time and psychological well-being [73]. A more recent review of sedentary behavior and PA similarly found that higher levels of PA were associated with better HRQoL and increased time of sedentary behavior was linked to lower HRQoL among children and adolescents [74].

Other reviews have focused only on PA and QoL or well-being, with mixed results. In primary school-aged children, null results were found between the PA program Loose Parts Play (LPP) and control groups for psychosocial QoL [75]. Joronen et al. reviewed studies of exergames on child and adolescent well-being, and exergaming was found to have some positive effects on psychological and social well-being [76]. Poitras et al.’s review of apparently healthy children and youth (including those with overweight and obesity) with a mean age of 5–17 years found available studies to be of poor quality with no consistent findings but did find that total PA (steps per day) was positively correlated with QoL [77].

Two SRs focused on specific segments of the youth population, both with limitations. One focused on at-risk youth (e.g., high risk, troubled, and antisocial) and identified 13 studies that examined the effects of three types of PA (i.e., outdoor adventure, sport- and skill-based, and physical fitness programs) on social and emotional well-being. However, while many of the interventions reported significant positive effects, the risk of bias was high in all of the included studies [78]. Another review of overweight or obese children from the age of 6 to 11 years examined behavioral treatments, which included PA. Unfortunately, few trials reported HRQoL outcomes, and none of the analyses demonstrated a substantial difference in these outcomes between intervention and control groups [79].

In sum, limited evidence suggested that among youth aged 5–18 years, greater PA and lower levels of sedentary time are associated with higher perceptions of QoL and well-being.

DEMENTIA

Overall, few reviews addressed the association between PA and QoL for individuals with dementia, and most did not support an association between PA and QoL for individuals with dementia. MA of six studies showed no significant differences in five of the studies for QoL outcomes for individuals in PA intervention groups compared with controls. The average effect was small and nonsignificant (SMD = 0.33 [95% CI: −0.21 to 0.87]). Also, when one outlier was excluded, the effect was not significantly different from 0 (SMD = 0.06 [95% CI: −0.10 to 0.22]). Modes of PA included aerobic training, strength training, combined aerobic and resistance training, flexibility, balance, Yoga, and Tai Chi [80].

Recent reviews have concluded that strong evidence indicates that exercise did not improve QoL in this population [81,82]; one review of SRs found no evidence on the benefits of exercise on QoL [83]. Two reviews reported on specific domains of QoL. One review found positive effects on selected domains of QoL, including physical role functioning [84], while a review with six randomized and controlled studies had mixed results for both global QoL and specific domains [85].

Overall, the evidence for an association between PA and QoL based on controlled studies was inconsistent, in part, due to the small number of studies that systematically evaluated QoL and well-being and inconsistency in outcome measures with respect to reporting generalized QoL versus disease-specific QoL outcomes. In addition, the number of studies and sample sizes were insufficient to adequately analyze effects of different exercise training modalities, and no studies differentiated their effects based upon the categorical type of dementia (Alzheimer’s disease [AD] and related dementias) or the stage(s) of dementia in the participants. In sum, there was
insufficient evidence to determine the association between PA and QoL and well-being in individuals with dementia.

**DEPRESSION AND BIPOLAR DISORDER**

A small but growing area of research focuses on the impact of PA on QoL and well-being in individuals with major clinical depression or bipolar disorder. Limited evidence from 11 controlled studies suggests that PA improves selected domains of QoL for adults with major clinical depression, while the evidence for bipolar disorder was insufficient [85–87].

MAs of four RCTs in adults with clinical depression comparing PA to either placebo or no PA found no differences for the mental (SMD = 0.24, 95% CI: −0.76 to 0.29), psychological (SMD = 0.28, 95% CI: −0.29 to 0.86), and social domains (SMD = 0.19, 95% CI: −0.35 to 0.74) [86]. However, two studies reported a moderate effect size for improved environment domain (SMD = 0.62, 95% CI: 0.06 to 1.18), and four out of four studies reported a moderate effect size for improved physical domain (SMD = 0.45, 95% CI: 0.06 to 0.83) in favor of the group assigned to structured PA. By contrast, controlled studies comparing PA to other therapeutic modalities for the treatment of depression, including cognitive therapy, as well as antidepressant medication, showed no between-group differences in the mental or physical domains of QoL [86]. A review of four RCTs in older adults with depression found that PA improved QoL in most reports [85]. One RCT comparing Yoga to a relaxation control group showed an improvement of 50% or greater on mental QoL domain in the Yoga group [87].

One review examined lifestyle interventions targeting dietary habits and exercise in individuals with bipolar disorder. Overall findings point toward a beneficial role of lifestyle interventions on PA and overall well-being; however, the magnitude is unknown [88]. In sum, limited evidence suggested that PA improves QoL and well-being for adults with major clinical depression and bipolar disorder.

**SCHIZOPHRENIA**

Moderate evidence supports the positive effects of PA on QoL for individuals with schizophrenia. These results come from consistent findings from SRs of studies involving inpatients and outpatients across the adult age span [89,90]. The positive effects of PA are shown by their effect size in MAs of 11 controlled or uncontrolled intervention studies that show significant improvements, with moderate standardized effect sizes for overall QoL (Hedges’ g = 0.55, p < .01) and for specific domains of physical (Hedges’ g = 0.50), social (Hedges’ g = 0.67), and environmental QoL (Hedges’ g = 0.62) [91]. Mental QoL did not change in this population (Hedges’ g = 0.38). Both aerobic exercise (Hedges’ g = 0.58) and Yoga interventions (Hedges’ g = 0.58) were found to be effective. Holley et al.’s SR found that PA has a beneficial effect on some attributes associated with psychological well-being in individuals with schizophrenia [92], but instruments used to measure psychological well-being varied across all studies, limiting the ability to compare results.

Several reviews focused on the impact of Yoga (varying forms) as PA on QoL and well-being in people with schizophrenia. An MA reported moderate evidence for short-term effects of Yoga on QoL compared to usual care (SMD = 2.28; 95% CI 0.42 to 4.14; p = .02), but these effects were only present in studies with high risk of bias. When comparing Yoga to exercise, no evidence was found for short-term effects on QoL (SMD = 0.17; 95% CI −0.27 to 0.61; p = .45) [87]. A small review of three RCTs reported that physical, psychological, social, and environmental HRQoL as measured with the abbreviated version of the WHO Quality of Life questionnaire (WHOQOL-BREF) increased more significantly after Yoga than after exercise or waiting list control conditions [89].

A series of SRs from Broderick et al. examined Yoga versus standard care [93], versus nonstandard care [94], and as part of a package of care versus standard care [95]. Promising effects were found, including differences in QoL in favor of the yoga group versus standard care [93]; however, nearly all of the studies examined were rated as low-quality evidence, had a small sample size, and had mixed results. In sum, moderate evidence indicated that PA improves QoL and well-being in individuals with schizophrenia.

**PARKINSON’S DISEASE**

An emerging area of research examines the impact of PA on QoL and well-being among people with Parkinson’s disease (PD). This topic was not covered in the PAGAC Scientific Report, but the results of two recently published MAs are summarized here. Lee et al. reported on the effects of nonpharmacological interventions on HRQoL including exercise programs with an effect size of −5.73 with 95% CI of −11.36 to 0.10 (Z = 2.00, p = .05) [96]. Thus, nonpharmacological interventions, and particularly exercise programs, were effective in improving HRQoL of PD patients [96].

Another MA suggested a potential benefit of Tai Chi Quan for improving QoL for individuals with PD [Effect Size = −0.393, p < .001] [97].

SRs, in addition to MAs, support the potential for PA to influence QoL and well-being among people with PD. Wu [98] found evidence to support the efficacy of PA to influence QoL for the PD population. Aerobic training exercise significantly improved the participants’ QoL scores, and a balance-training program, such as Tai Chi, also improved QoL [98]. A review of aquatic physiotherapy also suggested that it improved aspects of QoL [99]. A review of
Tai Chi studies found that participants enrolled in Tai Chi had improved well-being (one or more aspect) by the end of the program [100]. In sum, moderate evidence indicated that PA improves QoL and well-being in individuals with PD.

CHRONICALLY ILL POPULATIONS

Two recent SRs examined the evidence related to PA and QoL or well-being more broadly [101,102]. Zou et al. examined studies with Baduanjin Qigong as the mode of PA, and participants across studies included 559 adults with healthy status and 976 with different types of diseases (e.g., Type 2 diabetes mellitus, cancer, PD, hypertension, knee osteoarthritis, and chronic fatigue syndrome-like illness). The aggregated results showed significant benefits in favor of Baduanjin Qigong on QoL (SMD = −0.75; 95% CI −1.26 to −0.24; \( p = .004 \); [101]). Another review examined modern postural Yoga as a mental health promoting tool with conflicting results across samples of youth, middle-aged women, and older adults [102]. Given the small number of reviews and variable nature of the individual studies and sample makeup, a grade is not assignable.

DISCUSSION

Due to a lack of experimental studies, few MAs and SRs have focused on the impact of PA on well-being or QoL in older adults [103], let alone across a broad array of QoL and well-being. Thus, rigorous SRs of these reviews are even rarer. There has also been inconsistency in search strategies across prior reviews; thus, the exhaustive strategy we employed tried to be as inclusive as possible. The rigor of the current review, the large number of reviews included, and conclusions for various aspects of the population contribute to our knowledge on the topic of the relationship between PA and QoL and well-being.

The first aim of this umbrella review was to determine the relationship between PA and QoL and well-being. The strongest evidence existed for older adults and was based on the largest body of evidence. Adults also demonstrated a positive relationship between PA and QoL and well-being. The vast majority of studies included in the reviews were RCTs, though not all of them; thus, it is possible that unobserved third variables (e.g., functional ability) could create the appearance of an effect.

For several other populations, an insufficient number of studies and mixed- or low-quality studies included in the reviews provided weaker evidence. In some populations (e.g., neurologic and psychiatric conditions), it is much more difficult to conduct a well-controlled PA intervention of moderate intensity for any long period of time.

With the exception of evidence on the variation of results by age and sex (i.e., strong evidence of effects for adults and older adults, but limited evidence among youth), the other aims of the umbrella review (dose response and variation by race/ethnicity, socioeconomic status, or weight status) could not be evaluated because of absence of information on these topics in the SRs and MAs. Existing SRs were not written with similar goals as the current paper, so the reviews were not set up to examine whether associations varied by these factors. Also, we did not perform a quantitative MA of the existing reviews, so we are not able to discuss the moderating role of the variables. Unfortunately, SRs are not the best method for estimating dose–response relations or effect modifiers, and many research studies in the field do not systematically evaluate these relations.

One issue across populations included in this review was the lack of agreement across measures of QoL and well-being, which hinders research conclusions of the impact of PA on the outcomes. The most commonly used measures of QoL and well-being are shown in Table 2. Consistent measurement across studies would allow for more direct comparisons across studies and potentially across populations. With the different conceptualizations and measurement, it is possible and, perhaps, likely that slightly different constructs are actually being assessed in spite of the same labels/names of the constructs. As Marsh [104] described, we must be aware of the “jingle” fallacy (that scales with the same name measure the same construct) or its converse, the “jangle” fallacy (that scales with different names measure different constructs). That said, the

| Measures of QoL
| Short Form Survey (SF-36 and SF-12)
| Satisfaction with Life Scale
| MacNew global score
| World Health Organization’s (WHO) Quality of Life Questionnaire (WHOQoL)
| WHO Quality of Life Assessment—Module for Older Adults (WHOQoL-Old)
| EuroQol Group 5—Dimension Self-Report Questionnaire
| Life Satisfaction Index—A
| Disease- or population-specific measures
| Diabetes QoL instrument
| Alzheimer’s Disease Related Quality of Life
| Pediatric Quality of Life Inventory
| Measures of well-being
| WHO—Five Well-Being Index (WHO-5)
| Subjective Vitality Scale
| Positive and Negative Affect Schedule
| Lawton’s PGC Morale Scale
| Psychological Well-Being Scale
| Warwick–Edinburgh Mental Well-Being Scale

Table 2 | Commonly used measures of QoL and well-being
fact that the conclusions are reasonably consistent across variable measures demonstrates the strength and robustness of the findings.

Improvements in research design will accelerate the explication of the relationship between PA and QoL and well-being across populations. Rigorously designed and long-term experimental studies are needed. Although many current studies are promising, the use of more rigorous designs (e.g., RCTs) and longer intervention periods (e.g., more than 1 year) will bring needed clarity to the question of the impact of PA on QoL and well-being. Enrolling samples of sufficient size and diversity to support intervention moderator analyses (i.e., exploration of subgroup effects in relation to intervention success) along with mediator analyses (i.e., exploration of putative mechanisms through which the interventions operate) will provide useful information for adapting the interventions to optimize uptake among different subgroups, as well as to identify key elements of interventions that are essential to improving QoL. Incorporating diverse population subgroups, including diverse racial/ethnic groups and vulnerable and underrepresented population groups (e.g., lower-income residents and frail older adults), will expand the potential for having a broader public health impact in disseminating this research.

Furthermore, studies should be designed to examine factors that moderate intervention effects, including factors such as characteristics of the activities, person, or disease status. To date, research has focused on the average effects of PA across all individuals and activities. Identifying features of the person (i.e., individual differences) or of specific PA prescriptions that modulate these effect sizes will lead to more targeted and precise behavioral interventions to promote QoL.

Future research within specific populations is also needed. Research is needed to develop a more precise estimate of the effect of PA on QoL in people with dementia, to establish subgroups of optimal responders and nonresponders, and to identify the optimal activity prescription (particularly varying the intensity of physical activities). Subgroups of people with dementia who have been understudied include individuals at different stages of AD progression, individuals with other types of dementia, including, but not limited to, vascular, mixed, frontotemporal, and Lewy body dementia.

Research is also needed to understand how PA interacts with common treatments used by individuals with schizophrenia and effects on disease-specific factors related to QoL. Schizophrenia spectrum disorders include symptoms categorized as positive and negative. Antipsychotic medications are considered to be effective for many positive symptoms but not for negative symptoms and cognitive effects. Existing research suggests that these latter symptom categories may be improved with PA in this population. This research can elucidate how clinical and mental health factors, as well as the modality and setting (institutionalized vs. community or home) of PA, influence QoL outcomes.

Lastly, research is needed to establish the effects of PA on disease- and patient-specific factors related to QoL for individuals with depression and other depressive and bipolar disorders across the spectrum of aging. Most research has focused on the effects of PA on adults with major clinical depression. Knowledge gaps exist regarding the relationships between PA and QoL for individuals classified as having bipolar and related disorders and depressive disorders, including more recently defined conditions such as disruptive mood dysregulation and premenstrual dysphoric disorder [105]. These studies will help to clarify the roles moderators (e.g., patient-, activity-, and disease-status-specific factors) may play in influencing results by type of disorder and how they may interact with medical treatment(s) for these conditions. Future research should also examine the interaction of PA and psychiatric conditions across the lifespan.

In summary, the majority of evidence of the impact of PA on QoL and well-being is positive. That said, there are varying levels of impact on different populations and conditions and not enough evidence to make any conclusive statements of the relationship for some populations and conditions. Although there is a lot of research on the topic of QoL and well-being, more is needed to learn of the intricacies of the constructs and their relationship with PA. Future research is likely to expand upon the work of the PAGAC and could arrive at different conclusions for other populations of the impact of PA on QoL and well-being.

**SUPPLEMENTARY MATERIAL**

Supplementary material is available at Translational Behavioral Medicine online.

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**Compliance with Ethical Standards**
Conflicts of Interest: The authors declare that they have no conflicts of interest.


Ethical Approval: For this type of study, formal consent is not required. This article does not contain any studies with animals performed by any of the authors.

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