

# Effect of team sports and resistance training on physical function, quality of life, and motivation in older adults

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## Funding information

Nordea-fonden; Municipality of Copenhagen.

The aim of this study was to investigate the effect of team sports and resistance training on physical function, psychological health, quality of life, and motivation in older untrained adults. Twenty-five untrained men and forty-seven untrained women aged 80 (range: 67-93) years were recruited. Fifty-one were assigned to a training group (TRG) of which twenty-five performed team training (TG) and twenty-six resistance training (RG). The remaining twenty-one were allocated to a control group (CG). TRG trained for 1 hour twice a week for 12 weeks. Compared with CG, TRG improved the number of arm curls within 30 seconds ( $P < .05$ ) and 30-seconds chair stand ( $P < .05$ ) during the intervention. In TRG, participation in training led to higher ( $P < .05$ ) scores in the subscales psychological well-being, general quality of life, and health-related quality of life, as well as decreased anxiety and depression levels. No differences between changes in TG and RG were found over the intervention period, neither in physical function tests nor psychological questionnaires. Both TG and RG were highly motivated for training, but TG expressed a higher degree of enjoyment and intrinsic motivation mainly due to social interaction during the activity, whereas RG was more motivated by extrinsic factors like health and fitness benefits. In conclusion, both team training and resistance training improved physical function, psychological well-being, and quality of life. However, team sport training motivated the participants more by intrinsic factors than resistance training.

## KEYWORDS

accelerometer, aging, ball games, floorball training, psychological well-being, self-determination theory

## 1 | INTRODUCTION

Old age is associated with a decline in physical function. In particular, balance, ability to walk stairs, and standing up from a chair deteriorate with old age.<sup>1-3</sup> Also, the ability to perform activities of daily living declines and risk of falls and fractures increases with age reducing the independence of the older adults.<sup>4</sup> Regular physical activity can delay the deterioration of functional capacity with age<sup>5</sup> independent of the presence of other health problems.<sup>6,7</sup>

Perceived physical and psychological health, as well as quality of life, also decreases with old age.<sup>8,9</sup> One reason for this decline is that physical or health-related quality of life is tied closely to the apparently inevitable physical decline in old age.<sup>10</sup> Thus, attenuating or even reversing the physical decline by exercise training could have a positive impact on quality of life. However, other aspects of quality of life not tied to physical health, such as social relations and emotional well-being, also decrease as old age progresses.<sup>10</sup> Similarly, the prevalence of anxiety and depression is high in

older adults.<sup>11–13</sup> Given the broad health benefits of exercise, motivating training forms with broad-spectrum adaptations important for physical function in addition to positive social and psychological effects are needed.

A number of studies have shown that football training organized as small-sided games has positive effects on physiological variables important for health of young and older adults.<sup>14</sup> In addition, small-sided floorball training has shown to efficiently improve muscle strength and physical function in recreational active men aged 65–75 years.<sup>15</sup> Favorable social and psychological effects have also been demonstrated with team sport training organized as small-sided games.<sup>16</sup> Thus, participation in team sports may have positive benefits on psychological health and quality of life, beyond the effects of participation in physical activity.<sup>17,18</sup> Furthermore, team sports seem to be more motivating than individual physical activities due to a feeling of belongingness and competence in team sports.<sup>16</sup> However, the effect of participating in small-sided team sport games has not been examined in untrained older adults ( $\approx 80$  years).

Resistance training is widely used among older adults,<sup>19</sup> as physical function is closely related to strength and muscle mass.<sup>20,21</sup> However, resistance training has limited effects on aerobic capacity and cardiovascular fitness,<sup>22,23</sup> which is related to physical function and cardiovascular disease.<sup>24</sup> In addition, resistance training is often organized as an activity with limited social interaction.<sup>16</sup> However, small-sided team sports are characterized by a significant cardiovascular stimulus<sup>14</sup> and may also provide improvements in both physical function as well as psychological health and quality of life in older adults. However, these benefits of team sport still have to be investigated.

A reduction in other forms of physical activity during the remainder of the day may occur as a consequence of training interventions in older adults due to fatigue.<sup>25</sup> It may also lead to an increase in physical activity because of a feeling of more energy.<sup>26</sup> A direct method to measure daily physical activity is accelerometer recording. However, the effect of training interventions on nonexercise daily physical activity (NEPA) based on accelerometer measurements has yet not been examined, and it is not known whether team sports may affect NEPA differently than traditional resistance training in older adults.

Thus, the aim of this study was to investigate the effect of training organized as small-sided team sport games and resistance training on physical function, psychological health, quality of life, motivation, and nonexercise daily physical activity among older untrained adults. It was hypothesized that (1) team sport and resistance training would lead to similar improvements in physical function, (2) the training would improve psychological health and quality of life, and (3) team sport would lead to superior improvements in quality of life and motivation.

## 2 | METHODS

### 2.1 | Participants

Twenty-five men aged  $79 \pm 5$  (range: 71–87) years with a height, body mass, and body mass index (BMI) of  $1.70 \pm 0.08$  m,  $80 \pm 13$  kg, and  $28 \pm 4$  kg·(m<sup>2</sup>)<sup>−1</sup>, respectively, and forty-seven women aged  $80 \pm 7$  (range: 67–93) years with a height, body mass, and BMI of  $1.61 \pm 0.06$  m,  $74 \pm 15$  kg, and  $28 \pm 6$  kg·(m<sup>2</sup>)<sup>−1</sup>, respectively, were recruited from five elderly centers (see below) in the Municipality of Copenhagen.

The participants were untrained; that is, they were not performing exercise training more than twice per week, and they should be able to walk without aids, such as a walker or a wheelchair. Exclusion criteria were severe cardiovascular and neurodegenerative diseases, and severe cognitive disorders. All participants took medicine on a daily basis (Table 2). The study was approved by the local ethics committee of Copenhagen (H-15002409) and conducted in accordance with the guidelines of the declaration of Helsinki. The participants were informed of any risks and discomforts associated with the study before giving their written informed consent to participate in the study.

### 2.2 | Site of training intervention

The training intervention was conducted in municipal-based elderly centers, which offer a broad variety of activities for adults older than 65 years. One can become a member in the elderly center through a referral from their doctor to do training or other activities due to, for example, functional impairment, or one can turn up by own initiative and gain membership if the staff considers the person to have a physical, social, or mental need for daily offered activities. Currently, team sports are not offered as a part of the centers' activities.

### 2.3 | Design

The participants from three of the five elderly centers were randomized into a team training group (TG,  $n=25$ ) and a resistance training group (RG,  $n=26$ ) matched by gender, age, and SF-12 (see questionnaires below). Collectively, TG and RG were defined as the training group (TRG,  $n=51$ ). The remaining participants from the two other elderly centers were allocated to a control group (CG,  $n=21$ ). This setup was used for logistic reasons as there were not enough participants in each elderly center to divide them into three groups of acceptable size.

### 2.4 | Training

Before the training intervention, the elderly centers' staff were trained how to conduct and organize team and resistance training. During the first 2 weeks, students and

employees from the university supported or supervised the training, whereas the remaining training was conducted by the elderly centers' staff. Participants were told to attend at least two of three scheduled sessions weekly over 12 weeks. Each training session was preceded by a 10-minute warm-up session, including mobility and stretching exercises.

### 2.4.1 | Team training group

In TG, the training consisted of three different types of team sports with a ball, in which two teams played against each other. The training sessions were organized as intervals with 4 minute of playing followed by 4 minute of rest with three intervals ( $\approx 12$  minute per session) during the first 4 weeks, four intervals ( $\approx 16$  minute per session) during week five to eight, and five intervals ( $\approx 20$  minute per session) in week nine to twelve. The team sports included (1) small-sided floorball, which is a team sport like hockey, but played with plastic sticks,<sup>15</sup> (2) "cone ball," played by hitting the opponent's cones in the end of the lane with a softball. When a cone was hit, the scoring team moved the cone to their own site of the lane, and (3) "hula goal" played by throwing the ball through a hula ring, which a teammate had lifted to hip height. It was not allowed to score in the same ring two times in a row. No dribbling and steps with the ball were allowed in cone ball and hula goal. All team sport games were played 3 vs 3 or 4 vs 4 inside on a plastic floor sized  $\approx 10 \times 10$  m, and no physical contact was allowed. TG completed  $2.2 \pm 0.3$  training sessions a week.

### 2.4.2 | Resistance training group

In RG, training consisted of three exercises per session. In training week, one to four participants performed two sets of 10 repetitions maximum (RM) separated by 2-minute rest of each exercise, and three sets of 10 RM in training week five–twelve. The exercises were (1) squat with dumbbells (range 2–23 kg) in the hands standing up from and sitting down on a chair, (2) sitting shoulder flexion with a dumbbell in each hand (range 0.5–10 kg), and (3) sitting elbow flexion with a dumbbell in each hand (range 1–11.5 kg). RG completed  $1.9 \pm 0.4$  training sessions a week, which was not significantly different from the exercise compliance in TG.

## 2.5 | Heart rate response and activity profile during training

At two training sessions in week nine of the intervention period, the participants were wearing a heart rate monitor (Polar Team System, Polar Electro Oy, Kempele, Finland) to measure heart rate response during training. Activity profile during training sessions were analyzed (Time Motion app for iPad, Grant Abt) using video recordings. The analyses included duration of standing still, moving (defined as constantly moving

legs, eg, forward or side steps without actually moving position), walking, and fast walking or running including acceleration and short sprints. Furthermore, number of intense actions was determined, including rapid turns ( $>180^\circ$ ), rapid changes in direction ( $>90^\circ$ ), shots or throws, arms stretched over head, and hands under knees.

## 2.6 | Dropouts and injuries

A total of 28 participants dropped out after randomization (TG,  $n=12$ ; RG,  $n=7$ ; CG,  $n=9$ ). Reasons for dropout were (1) the feeling that training and testing was too intense because of both physical or mild cognitive limitations ( $n=10$ ), (2) injuries or feeling of pain not related to the training intervention ( $n=7$ ), (3) did not show up for testing after the training intervention ( $n=5$ ), (4) minor injuries or feeling of pain during the training ( $n=3$ ), (5) lack of time to or interest in completing training ( $n=2$ ), and (6) no defined reason ( $n=1$ ). No major injuries were associated with the exercise interventions. When minor injuries occurred (eg, muscle-tendon soreness), the participant were told to skip training (eg, 1–2 weeks) until recovery.

## 2.7 | Testing and measurements

Participants were tested before and after the 12-week intervention period. This testing included functional tests (see *Physical function*) as well as a questionnaire battery (see *Questionnaires*) and qualitative individual interviews (see *Interviews*). In addition, accelerometer measurements were taken before and during the intervention (see *Daily physical activity measurements*).

### 2.7.1 | Physical function

Participants were instructed to refrain from strenuous exercise 36 hours before the test day, and participants on medicine were instructed to take their habitual medicine on the experimental days.

Participants completed the following tests from the senior fitness test battery.<sup>27</sup> (1) Arm curls, that is, maximal repetitions of bicep curls in 30 seconds with a dumbbell of 5 lbs (2.27 kg) for women and 8 lbs (3.63 kg) for men, (2) chair stands, that is, maximal repetitions of full stands rising and sitting down from a chair in 30 seconds with arms folded across chest, and (3) 2.45-m up-and-go, that is, time to get up from seated position, walk 2.45 m, turn, and return to seated position on chair.

### 2.7.2 | Questionnaires

The Danish version of the SF-12<sup>8</sup> was used to measure self-perceived physical and psychological health. It contains 12

questions that measure eight subscales of self-perceived health, namely (1) physical function, (2) physical limitations, (3) physical pain, (4) general health, (5) energy, (6) psychological limitations, (7) psychological well-being, and (8) social well-being. The questions have different answer formats, ranging from yes/no to a Likert scale from 1 to 6. The SF-12 has been validated for the sample and produce valid results comparable with the longer version, the SF-36.<sup>8</sup>

A Danish version of the Older People's Quality of Life questionnaire (OPQOL<sup>9,28</sup>) was used to assess quality of life in the participants. It contains eight subscales of quality of life, namely (1) life in general, (2) health, (3) social relations and leisure-time, (4) independence, control over life and freedom, (5) psychological and emotional well-being, (6) home and neighborhood, (7) financial circumstances, and (8) religion/culture. As the intervention was not expected to affect (6) home and neighborhood, (7) financial circumstances, and (8) religion/culture, these subscales were excluded, leaving 25 questions in the questionnaire. The questions have a Likert scale answering format from 1 (disagree a lot) to 5 (agree a lot). The questionnaire has been constructed specifically for a sample of older adults<sup>28</sup> and was translated from English to Danish and back-translated by four experts in psychological measurement (two for translation and two for back-translation), who met to discuss differences in translation version and to agree on a final translated version.

A Danish version of the Hospital Anxiety and Depression Scale (HADS<sup>29</sup>) was also used to assess psychological health in the participants. It contains two subscales, namely (1) anxiety and (2) depression. Each subscale contains seven questions, with a Likert scale answering format from 1 to 4, whose end points differ depending on each question. The questionnaire has been validated in Danish.

### 2.7.3 | Daily physical activity measurements

Measurements of NEPA for TG and RG were conducted during 1 week starting 14 days prior to the intervention and in week eight during the intervention period. For practical reasons, it was only possible to measure NEPA for CG during the intervention period. The activity level of the participants was measured by way of a triaxial accelerometer (AX3, Axivity, UK) placed on the right thigh for 7 days. Acti 4 software<sup>13</sup> was used to discriminate between physical activity types (sitting, standing, moving, walking, running, cycling, and transitions from sitting to upright stand) based on threshold values of standard deviation of acceleration and the derived inclination. Daily time (hours per day) and also changes over time (pre- vs during intervention) for the above-mentioned activity types were calculated. NEPA was calculated by subtracting exercise training from total daily physical activity at mid-intervention and subtracting activities at the same time interval the same days before the intervention.

## 2.8 | Interviews

To gain insight into the participants' experiences, individual interviews were conducted with a sample of the participants. Following an opportunistic sampling strategy, we approached those participants, who used the facilities of the elderly centers during the interview period 2-4 weeks after the intervention. Of the 34 participants who were post-tested in the end of the intervention, 16 (7 males and 9 females) were interviewed. Nine interviewees had participated in team sport training and seven in traditional resistance training; the interviewees trained in one of the three intervention centers. The interview guide was inspired by observations of training sessions during the intervention and the self-determination theory's conception of intrinsic and extrinsic motivation.<sup>30</sup> The aim was to discover if there were differences in experiences and motivation among the participants, and if so, to what these differences could be attributed. The interviews were carried out according to Patton's semistructured interview guide approach,<sup>31</sup> which allows a rather informal and conversational atmosphere, and provides the possibility for the interviewer to follow comments or topics raised by the participants. It gives the interviewer freedom to vary the wording and the order of questions; however, it still ensures that all topics in the interview guideline are covered. The interview progression was based on a "funnel approach",<sup>32</sup> starting with open and exploratory questions, and subsequently using more structured and specific questions. The interviews were conducted by the third author, experienced in qualitative research, who knew most of the participants from informal observations and an introductory workshop. Before the interviews, the participants were informed of the purpose of the study, that recordings would be anonymous and that they could choose not to participate in the interviews or drop out without consequences. The interviews were tape-recorded and lasted between 14 and 49 minute. The relevant parts of the interviews were transcribed and coded in the software program Atlas.ti. A list of a priori codes were derived from the research questions and the theoretical framework, together with additional codes that emerged inductively during the coding process (see, eg,<sup>33,34</sup>). From this comprehensive list of codes, we identified "pattern codes," which allowed us to condense the material and capture overarching themes,<sup>34</sup> and from here, data were thematically analyzed.<sup>31</sup>

To guarantee the interviewees' anonymity, we replaced their names by pseudonyms and removed any identifying information. Quotations cited in the paper have been translated by the interviewer from Danish to English.

## 2.9 | Statistics

Group differences in age, BMI, all subscales of SF-12, OPQOL, and HADS, physical function and daily physical



activity at baseline as well as heart rate data obtained during training sessions were tested with a one-way ANOVA. Group differences in gender and medicine intake were tested with a Pearson chi-square test. To test effects of the training intervention, TG and RG were pooled to a training group (TRG), and linear regression analyses were used, in which measurements at the end of the intervention were used as dependent variables, and measurements before the intervention and group affiliation (TRG or CG) were used as independent variables. To test whether TG had superior effects over RG, linear regression analyses were used, in which measurements at the end of the intervention were used as dependent variables, and measurements before the intervention and group affiliation (team sports or resistance training) were used as independent variables. Linear regression analyses were also used to investigate group differences in changes in NEPA from before intervention to during the intervention. An inference about population effects approach was applied to the physical function variables of the present study.<sup>35</sup> The change from pre- to postintervention was calculated and evaluated by a one-sample *t* test. A 90% confidence interval was calculated, and the probability of a beneficial, trivial, or harmful effect was inferred by defining threshold values and using a *t* distribution (Table 6). IBM SPSS statistics 22.0 (www.spss.com) was used for all tests. Results are presented as mean+SD unless otherwise indicated. The significance level was set to  $P < .05$ .

### 3 | RESULTS

#### 3.1 | Baseline measurements

Prior to the intervention period, no differences between TG, RG, and CG in gender, physical function, daily physical activity, and in any of the subscales of self-perceived health, psychological health, and quality of life were found (Table 1). Similarly, there were no differences in medicine intake (Table 2).

#### 3.2 | Heart rate and activities during training

In TG, mean heart rate during training was  $99 \pm 21$  beats per minute (bpm), which was higher ( $P < .05$ ) than in RG ( $82 \pm 13$  bpm; Figure 1). In TG, heart rate was above 110 bpm for  $14 \pm 14$  minute during training, which was higher ( $P < .05$ ) than in RG ( $2 \pm 4$  minute, Figure 1). The activities during a training session for the subjects in TG are presented in Table 3.

#### 3.3 | Physical function

In TRG, the number of arm curls and number of repetitions in 30-s chair stand increased ( $P < .05$ ) during the intervention

compared with CG. Although it was approaching significance, no change in 2.45-m up-and-go performance was observed for TRG (Table 4). No differences in the development in arm curl and 30-second chair stand were observed between TG and RG (Figure 2).

#### 3.4 | Psychological effects

In TRG, the subscales psychological well-being, general quality of life, and health-related quality of life increased ( $P < .05$ ), and the subscales anxiety and depression decreased ( $P < .05$ ) compared with CG, whereas no differences in development were observed in the subscales perceived physical function, limitations, pain, general health, energy, psychological limitations, social well-being, and social and emotional quality of life (Table 4). No significant differences in development were observed between TG and RG.

#### 3.5 | Motivation and adherence to the activities

The motivation to engage in training and adhere to the activities seemed to differ between the two training groups. In TG, the interviewees agreed upon that the playful environment of ball games and team sport has been the main component of their motivation to participate and become absorbed in the activity:

*You feel quite 'high' afterward, and we are almost wild. Kind of like a full international match. And so it is, you haven't had a ball in your hand for 100 years, and then suddenly you have a ball, and it actually seems really nice... so you want to go home and buy a ball... The fact is that you realize, how much joy it brought many years ago, and that you can really get the joy out of it - again. I think that's pretty amazing (Beth)*

Participation in team games created positive experiences and remembrances of childhood and youth and some participants even expressed the feeling of losing track of time and space, as well as forgetting their physical or mental limitations. One of the participant, who had to use walking aids for transportation to and from the center, forgot her limitations during the game and expressed her experiences as followed: "I forgot that I cannot run" (Emma). Another participant from TG named enjoyment as the key reason for his adherence to the activity during the intervention period: "We laughed and laughed. It was really fun. Bloody hell, we have laughed so much. It was good, it really was. Otherwise, I wouldn't have come anymore" (Peter).

For the members of the RG, on the other hand, the motivation and the key reason to participate throughout the

	TG	RG	CG	<i>P</i> -value
N	13	19	12	
Men	4	9	6	.618
Women	9	10	6	.618
Age (years)	79.0 ± 7.2	79.2 ± 6.6	81.3 ± 5.1	.592
Body height (m)	1.66 ± 0.10	1.64 ± 0.08	1.67 ± 0.07	.574
Body mass (kg)	74.6 ± 10.7	80.4 ± 15.3	71.6 ± 8.6	.148
BMI (kg/m <sup>2</sup> )	27.1 ± 4.4	29.6 ± 5.3	25.6 ± 2.3	.051
Physical function				
Arm curls (repetitions in 30 s)	14.5 ± 3.0	14.2 ± 3.2	14.8 ± 2.3	.855
Sit to stand (repetitions in 30 s)	12.1 ± 3.5	12.1 ± 2.6	11.8 ± 1.9	.941
2.45-m up-and-go (s)	7.0 ± 1.4	7.8 ± 2.3	7.4 ± 1.9	.520
Self-perceived health				
Physical function	2.1 ± 0.6	2.3 ± 0.6	2.4 ± 0.7	.456
Physical limitations	1.6 ± 0.5	1.4 ± 0.4	1.5 ± 0.5	.461
Physical pain	2.5 ± 1.0	1.9 ± 1.0	2.3 ± 1.4	.389
General health	2.7 ± 0.5	3.1 ± 0.8	3.1 ± 0.9	.319
Energy	3.7 ± 1.1	3.7 ± 1.6	3.3 ± 1.2	.721
Psychological limitations	1.5 ± 0.4	1.4 ± 0.5	1.4 ± 0.5	.810
Psychological well-being	4.8 ± 0.8	5.0 ± 1.0	5.0 ± 0.6	.764
Social well-being	1.8 ± 0.9	1.6 ± 0.7	2.1 ± 1.0	.369
Psychological health				
Anxiety	10.8 ± 2.8	10.8 ± 4.2	10.1 ± 2.7	.491
Depression	8.9 ± 1.6	10.2 ± 3.2	9.6 ± 3.1	.558
Quality of life				
General	4.4 ± 0.6	4.2 ± 0.7	3.8 ± 0.8	.148
Health related	3.5 ± 0.5	3.7 ± 0.6	3.8 ± 0.8	.632
Social	4.0 ± 0.6	3.8 ± 0.5	3.9 ± 0.5	.609
Emotional	4.2 ± 0.7	4.1 ± 0.6	4.2 ± 0.5	.981
Nonexercise daily physical activity				
Sitting time (min per day)	618 ± 114	684 ± 102	612 ± 72	.228
Steps per day (n)	6675 ± 2444	5524 ± 3057	4255 ± 2329	.138
Walking Fast, more than 99 steps per minute (min per day)	39 ± 21	34 ± 21	23 ± 16	.245

Data are presented as mean ± SD.

**TABLE 1** Participant characteristics, physical function, self-perceived health, psychological health, quality of life, physical activity, and sitting time before the intervention period for the team sport (TG), resistance training (RG), and the control group (CG)

intervention period seemed to be linked to more “utilitarian” drives such as losing weight continue with the rehabilitation training or similar health-related aims: “I do not want to be a ‘he- man’, it wasn’t that I aimed at. I wanted to have some better legs and an easier breath and things like that” (Harald).

Similar perspectives were named by other participants in the group, who stated that the physical benefits achieved from the training were the key reasons for their participation. Harald emphasized on how the sweat and the hard work, but also the companionship during the resistance training, were benefits of the participation in the intervention: “I will not cheat myself. When I am here I will do something. Otherwise, I might as well stay at home. Okay, of course there is the spirit of solidarity but the training, I think it’s great” (Harald).

Similar to the interviewees quoted above, participants in RG highlighted that they valued the effect of the training higher than spirit of solidarity that emerged as part of exercising in a group. The effect of “hard work” was closely related to their individual aims, and for many of them it was also related to an overall achievement of a sense of well-being: “It can be hard while doing it, but afterwards you always feel that you have used your body” (Paul). In that regard, their experiences of training were rather related to the effect physical activity can have on the feeling of a physical and mental well-being.

Against the background of self-determination theory, the statements of the interviewees about the benefits of the training indicate an extrinsic motivation, as they mainly performed the activities for the positive consequences, such as health or other physical benefits.

**TABLE 2** Use of medication in the team sport (TG, n=13), resistance training (RG, n=19), and the control group (CG, n=12)

	TG (%)	RG (%)	CG (%)	P-value
Intake of medicine	100	100	100	
Specific purpose of drug administration				
Blood pressure lowering	67	76	60	.586
Cholesterol lowering	33	41	30	.822
Against diabetes	17	29	30	.693
Against heart disease	42	29	40	.757
Against anxiety	0	0	10	.226
For better mood	0	0	10	.226
Another medicine	58	29	20	.133

Data are presented as percentage of participants using medicine within each group.

In contrast, the participants in TG did not seem to be concerned about physiological improvements and future gratifications, while they were engaged in the team games. Moreover, they did seem to reflect about their performance, that is, about the quality of their play or the outcomes of the game.

Overall, the statements of the members of TG indicated a high degree of enjoyment and also a higher degree of intrinsic motivation for participation than the statements of RG members who took part in resistance training. The participants in RG seemed to be more driven by extrinsic motivation for the activity.

### 3.6 | Elements of social connectedness and cohesion as a motivational factor

TG focused more than RG on the element of well-being, which was considered as a social component, related to social connectedness and cohesion. This is outlined in the statement of Tina:

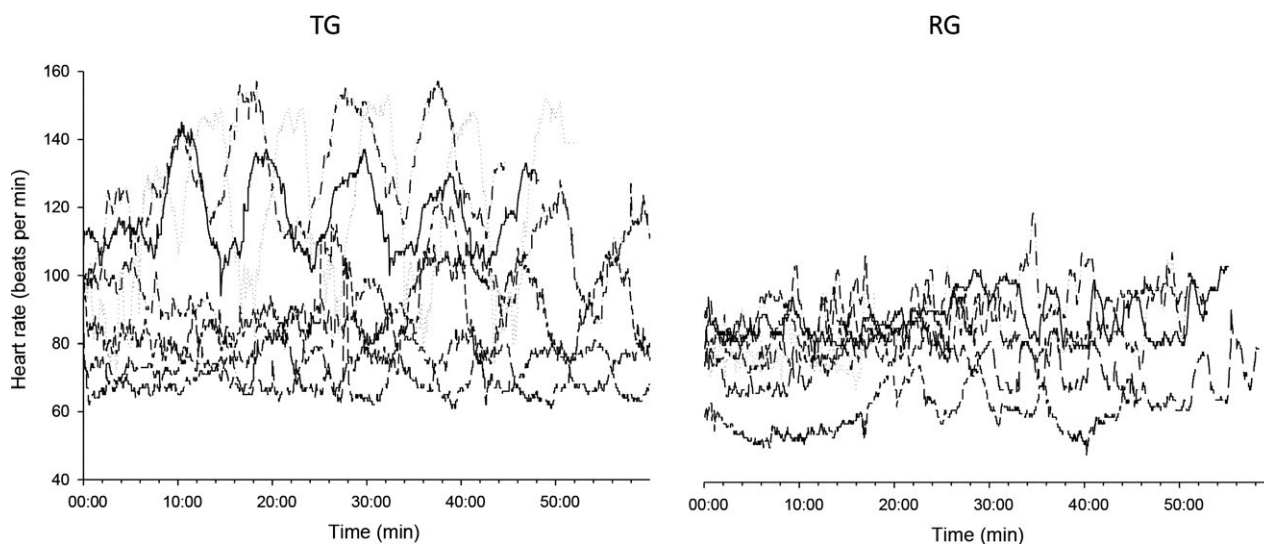
**TABLE 3** Activity profile during a training session of 5 × 4 min in the team sport group (TG, n=10)

Type of activity	Duration (min)
Standing still	5:24 ± 0:22
Moving	6:34 ± 0:05
Walking	6:36 ± 0:21
Fast walking/running	0:45 ± 0:05
Accumulated time	19:30 ± 0:07
Intense actions	Number of repetitions
Turning at least 180°	64 ± 3
Rapid changes of direction at least 90°	29 ± 3
Shot or throw	74 ± 3
Arm or arms stretched over head	23 ± 2
Hand under knees	41 ± 7
Intense actions in total	223 ± 8

Data are presented as mean ± SD.

*There is something social in it. The other thing [resistance training] is somehow more private. You stand there and do resistance training. It is the thing about doing something socially, where you are with someone, and you have to relate to someone (...) It is the social I like (...). In the beginning, one thought only of oneself 'I would like to make a goal' (...). But something social happened by being together, we talked together and started playing with each other. Started to have an interest in each other.*

The physical interaction on the playing field created a space for social interaction, which developed throughout the 12-week intervention. Tina describes, how the activity

**FIGURE 1** Heart rate response during a 1-h training session in the team sport (TG, n=7) and the resistance training group (RG, n=7)

initially had a focus on the game in itself as well as on the individual performance, whereas it transformed into being a team performance, which also resulted in interaction outside of the playing field.

This social and joyful environment, and the element of “getting closer to each other” through the physical and social interaction, was more present among the participants engaged in team sport than among participants engaged in resistance training. The fun and joyful experiences shared during the period of training seemed to enhance social capital and create new social networks. For many engaged in team sport, it was the prominent reason for the continued participation in the 12-week period:

*Because you are alone, live alone and things like that... I have a fine network, but every single day I look forward to go here, I do. I think every time you come, you go straight and talk with some of the others (Rosaline).*

Rosaline, who in the interview called herself a reserved person, expresses how the 12 weeks of training has contributed to an enriched social network, which she valued as she is living by herself. Similar statements were seen in other interviews

demonstrating that the social interaction occurring during the game produced new relationships.

Participants in both groups stated that the regular weekly training was something positive in their life as the following is an example of: “It has been an anchor in daily life—something to look forward to” (Susie). Both groups mentioned the extrinsic motives of health and fitness benefits and social relations, although health and fitness benefits were more pronounced in the interviews in RG, while the importance of establishing new social relations through the activity seemed more prominent in TG. The main difference between the groups was that while resistance group mainly focused on the mentioned extrinsic motives, the team group expressed a higher degree of enjoyment and intrinsic motivation, mainly due to social interaction during the activity. This confirms our hypothesis that that regular participation in team sports would have superior effects on motivation compared with resistance training.

### 3.7 | Nonexercise daily physical activity

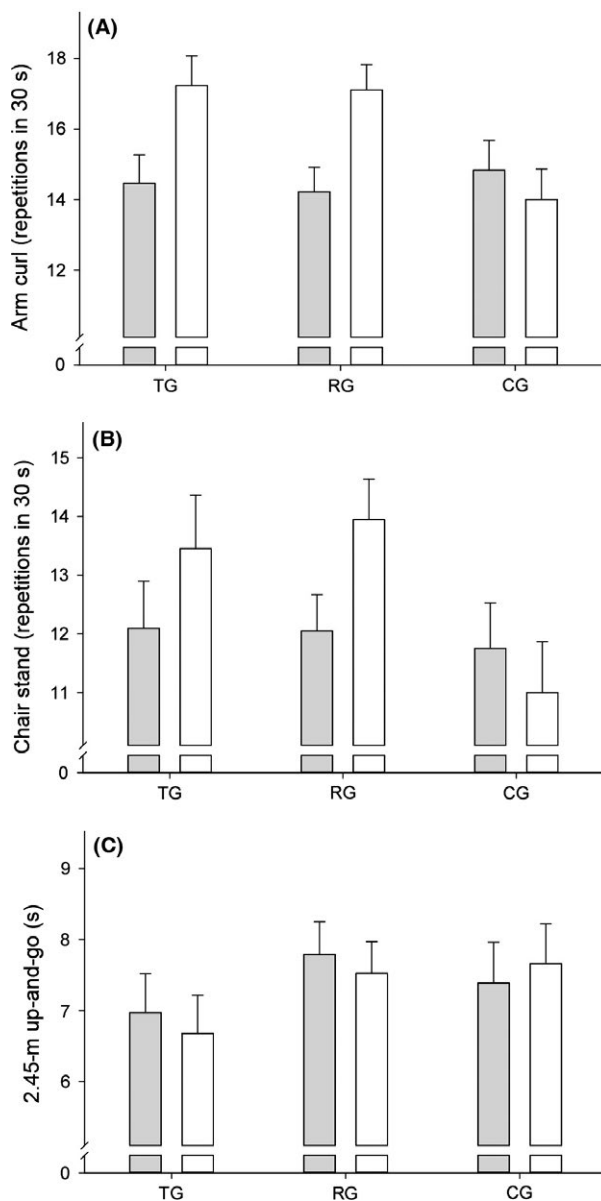
In TG and RG, nonexercise sitting time during a day was lower ( $P < .05$ ) during compared with before the intervention period (Table 5). The duration of standing, moving, walking,

**TABLE 4** Intervention effects and mean values before (pre) and after (post) the intervention for physical function, self-perceived health, psychological health, and quality of life in the training group (TRG) and the control group (CG)

	TRG		CG		<i>B</i>	<i>P</i> -value
	Pre	Post	Pre	Post		
Physical function						
Arm curls (n)	14.3 ± 3.1	17.2 ± 2.9	14.8 ± 2.3	14.0 ± 3.1	3.5 ± 0.7	<.001
Chair stand (n)	12.1 ± 2.9	13.8 ± 3.2	11.8 ± 1.9	11.0 ± 2.3	2.5 ± 0.6	<.001
Up-and-go (s)	7.5 ± 2.0	7.2 ± 1.9	7.4 ± 1.9	7.7 ± 2.0	0.5 ± 0.3	.055
Self-perceived health						
Physical function	2.2 ± 0.6	2.2 ± 0.5	2.4 ± 0.7	2.4 ± 0.5	n.s.	.533
Physical limitations	1.5 ± 0.5	1.4 ± 0.5	1.5 ± 0.5	1.6 ± 0.5	n.s.	.291
Physical pain	2.2 ± 1.0	2.0 ± 1.0	2.3 ± 1.4	2.1 ± 1.2	n.s.	.892
General health	2.9 ± 0.7	3.0 ± 0.9	3.1 ± 0.9	3.1 ± 0.9	n.s.	.996
Energy	3.7 ± 1.4	4.0 ± 1.2	3.3 ± 1.2	3.3 ± 1.9	n.s.	.259
Psychological limitations	1.5 ± 0.4	1.2 ± 0.4	1.4 ± 0.5	1.2 ± 0.4	n.s.	.989
Psychological well-being	4.9 ± 0.9	5.1 ± 0.9	5.0 ± 0.6	4.6 ± 1.1	0.5 ± 0.3	.043
Social well-being	1.7 ± 0.8	1.6 ± 0.8	2.1 ± 1.0	2.1 ± 1.1	n.s.	.423
Psychological health						
Anxiety	11.1 ± 3.5	10.8 ± 3.1	10.1 ± 2.7	11.0 ± 2.4	1.2 ± 0.6	.040
Depression	9.6 ± 2.7	8.6 ± 1.6	9.6 ± 3.1	10.0 ± 3.5	1.4 ± 0.6	.018
Quality of life						
General	4.3 ± 0.6	4.4 ± 0.4	3.8 ± 0.8	4.0 ± 0.8	0.3 ± 0.2	.025
Health related	3.6 ± 0.6	3.8 ± 0.6	3.8 ± 0.8	3.1 ± 1.1	0.7 ± 0.3	.006
Social	3.9 ± 0.6	4.0 ± 0.6	3.9 ± 0.5	3.9 ± 0.6	n.s.	.559
Emotional	4.2 ± 0.6	4.3 ± 0.6	4.2 ± 0.5	4.2 ± 0.5	n.s.	.306

Data are presented as mean ± SD and unstandardized B-coefficients ±SE from the linear regression analyses. n.s., not significant ( $P > .05$ ).





**FIGURE 2** (A) Maximal number of arm curls in 30 s, (B) maximal chair stand repetitions in 30 s, and (C) time to perform 2.45-m up-and-go before (gray bars) and after (white bars) the 12-wk intervention period for the team sport (TG,  $n=13$ ), resistance training (RG,  $n=19$ ), and the control group (CG,  $n=12$ ). Data are presented as means  $\pm$  SD

fast walk, running, cycling, and transitions from sitting to up-right position was the same during compared with before the intervention period in TG and RG (Table 5). No differences in NEPA were observed between TG and RG (Table 5).

## 4 | DISCUSSION

The present study has a number of important findings, including (1) a training intervention does produce improvements in physical function for older adults with similar improvement with team sport and resistance training, (2) a training

intervention improves psychological well-being, general quality of life, and health-related quality of life as well as decreases anxiety and depression levels in older adults with no difference between team sport and resistance training, (3) higher intrinsic motivation was developed in the older adults when participating in team sports than in resistance training as a result of more participant interaction, leading to a higher feeling of social connectedness, and (4) participation in regular team sport and resistance training maintained NEPA and led to lower daily sitting time.

### 4.1 | Physical function

The team sport training improved arm curl and chair stand performance to a similar extent as resistance training. This is in line with the observation by Andersen et al.,<sup>22</sup> who found similar improvements in chair stand after a period of regular small-sided football games and resistance training in healthy older men. The team sport training in the present study was characterized by multiple intense actions, including rapid changes in direction, which require high rate of force development. Thus, the dynamic activities in the team sport games with a ball may have contributed to the improved physical function. The better performance in arm curls and chair stand after resistance training was expected as specific chair stand and arm curls exercises were included as a part of the training intervention.<sup>36</sup> The improved functional capacity could potentially reduce accidental falls and injuries in everyday life in the older adults. Surprisingly, no effect of the training was observed in the 2.45-m up-and-go test, which may be due to statistical low power, as a strong tendency for an overall effect of training was observed ( $P=.055$ ). Thus, progressive statistics showed that team sport and resistance training may be beneficial for 2.45-m up-and-go performance for a considerable part ( $\approx 34\%$  and  $40\%$  of the participants, respectively). In contrast, a lifestyle without regular training in old age may for some lead to a decline in physical function ( $\approx 18\%$ ,  $11\%$ , and  $36\%$  of the participants in the control group for arm curls, chair stand, and 2.45-m up-and-go, respectively) during a period of 12 weeks (Table 6).

In TG, heart rate was above 110 bpm for 14 minutes during a training session ( $\approx 28$  minute weekly), which may have resulted in favorable cardiovascular adaptations. This could not be confirmed as it was not possible in this study to measure aerobic capacity. In a study by Vorup et al.,<sup>15</sup> recreational active men aged 65–75 years played floorball with a heart rate above 80% of maximum heart rate for 48 minute a week in 12 weeks resulting in a significant reduction in resting and submaximal exercise heart rate, indicating a higher aerobic capacity. In RG, heart rate was rather low during training (Figure 1) and may not have had an impact on aerobic capacity.

Activity	TG		RG	
	Pre	During	Pre	During
Sitting (min)	631 ± 106	562 ± 139*	645 ± 97	608 ± 98*
Standing (min)	157 ± 50	168 ± 61	112 ± 44	133 ± 78
Moving legs, but not walking or running or cycling (min)	52 ± 12	59 ± 24	47 ± 22	49 ± 21
Walking (min)	40 ± 12	47 ± 17	49 ± 29	47 ± 19
Running (min)	0.1 ± 0.2	0.1 ± 0.1	0.1 ± 0.1	0.04 ± 0.1
Cycling (min)	10 ± 16	11 ± 16	5 ± 11	10 ± 14
Walking fast, more than 99 steps per min (min)	26 ± 10	34 ± 13	32 ± 23	31 ± 15
Steps (number)	4599 ± 1621	5576 ± 1883	5489 ± 2946	5263 ± 1931
Transitions from sitting to upright position (number)	51 ± 20	52 ± 25	48 ± 20	45 ± 20

Data are presented as mean ± SD.

\*Significantly different ( $P < .05$ ) from pre.

**TABLE 5** Changes in non-exercise daily physical activity in the team sport (TG, n=13) and resistance training group (RG, n=19) before (pre) and during the intervention

## 4.2 | Nonexercise daily physical activity

The present study demonstrated that neither team sport nor resistance training resulted in lower NEPA. In fact, daily sitting time was lower on days of training compared with before the intervention period. In contrast, Goran & Poehlman<sup>25</sup> observed that in healthy older adults endurance training three times a week at 85% of their maximal oxygen uptake ( $VO_{2max}$ ) did not increase total daily energy expenditure, because of a decline in physical activity during the remainder of the day.<sup>25</sup> The maintained level of NEPA and the reduced sitting time in the present study may be considered important, as a low physical activity level and high sitting time are associated with an increased high risk of cardiovascular disease.<sup>37,38</sup>

## 4.3 | Psychological effects of training

Several positive effects of training were observed. Psychological well-being, general quality of life, and health-related quality of life all increased in TRG compared with CG. Similarly, anxiety and depression levels decreased in TRG compared with CG. These results support earlier findings which conclude that exercise is beneficial for psychological health.<sup>10</sup> Reviews on the relationship between psychological health and exercise suggest that aerobic exercise is especially important,<sup>39</sup> and this led to our hypothesis that team games would have beneficial effects compared with resistance training and control. However, this was not confirmed by our results. It may be that the lower activity level found among these older participants creates opportunities for psychological benefits, even from physical activities that provide only a marginal aerobic effect. In the subscales of SF-12, there was only a positive development in psychological well-being. It was hypothesized that the rest of the subscales also showed a positive development, but the

results did not support this. Some reasons for this may be: (1) lack of power, (2) lack of item sensitivity, and (3) participant cognitive functioning. It is obvious that with only 32 participants in the TRG and 12 in the CG, the lack of power makes the risk of type 2 error real. Additionally, while the SF-12 has been shown to produce results similar to the SF-36,<sup>8</sup> it uses only 12 items to measure eight constructs, leaving four with only one item, and four with two items. Of the 12 items, two of these have an answering format with three choices, and four have a yes/no answering format, leaving little room for minor changes. Lastly, the cognitive functioning of the participants, which was quite low in some of the participants, could make their answers, and hence the results, less sensitive to changes. Together, although some of our hypotheses in the SF-12 were not supported, a number of studies suggest that exercise training can have a positive effect on self-perceived health,<sup>18</sup> supporting that the hypotheses could have been confirmed, if a larger sample was available.

Anxiety and depression levels decreased in TRG compared with the CG, which was in line with the hypothesis. The positive effect of exercise on anxiety and depression is well established,<sup>39–41</sup> and the results of the present study confirm the relationship in a sample of older adults with low daily activity levels. Lastly, the positive development in general and health-related quality of life confirmed the hypotheses, while the results concerning the social and emotional quality of life did not. It was not surprising that TRG improved in health-related quality of life, as this is closely tied to physical function (which was improved in TRG) and which previous studies confirms.<sup>10</sup> As general quality of life depends in part on health-related quality of life, this result is expected. However, social and emotional quality of life did not improve with the intervention period. While social interaction can be increased through the physical activities (as previously stressed by the qualitative findings), it would

**TABLE 6** The chance that the observed changes in physical function would be beneficial, trivial, or harmful in the team sport (TG), resistance training (RG), and the control group (CG)

	Arm curl	30-s chair stand	2.45 up-and-go
TG			
90% CI	[1.8;3.8]	[0.38;2.3]	[−0.55;−0.03]
<i>P</i>	.0004	.03	.07
Threshold	2 Repetitions	1.5 Repetitions	−0.35 s
Inference			
Beneficial (%)	90%	40	34
Trivial (%)	10	60	66
Harmful (%)	0	0	0
RG			
90% CI	[1.9;3.9]	[1.1;2.7]	[−0.81;0.27]
<i>P</i>	.0001	.0004	.4
Threshold	2 Reps/30 s	1.5 Reps/30 s	−0.35 S
Inference			
Beneficial (%)	99	81	40
Trivial (%)	1	19	57
Harmful (%)	0	0	3
CG			
90% CI	[−2.1;0.43]	[−1.8;0.29]	[−0.12;0.66]
<i>P</i>	.26	.22	.24
Threshold	2 Reps/30 s	1.5 Reps/30 s	−0.35 S
Inference			
Beneficial (%)	0	0	1
Trivial (%)	82	89	63
Harmful (%)	18	11	36

Data are presented as 90% confidence intervals (90% CI) for the variables within each group, and the *P*-value (*P*) for paired-sample *t*-test is given. A subjectively chosen threshold for the minimal change that could be considered beneficial (Threshold) was used to calculate the Inference.

not have affected the participants' current relationship with friends and family. Similarly, the activities may have affected emotional quality of life during the activities, but the rest of the participants' lives, and hence the main source of emotional quality of life, remained the same. Therefore, the effect might have been too small to be measured by the OPQOL.

#### 4.4 | Motivation and adherence to the activities

While the psychological effects between TG and RG did not differ, the qualitative interviews revealed important differences between TG and RG participants' experiences of the training. It seemed that RG participants had mainly extrinsic motives for training, such as better health and fitness, while the TG participants had mainly intrinsic motives for participating, such as enjoyment and fun. These results support earlier findings on the differences in experiences between team

games and individual physical activity, where the team game elicited not only higher intrinsic motivation, but also higher participation rates after the intervention.<sup>16</sup> Intrinsic motivation has been shown to facilitate continuation,<sup>42–44</sup> so activities that elicit this form of motivation are preferred. Hence, to promote continuation, team game participation seems to be the better choice over resistance training participation. However, it will require additional qualitative research aims and presumably a longer intervention period to have a closer insight into the potentials of social interaction and social cohesion and the relation to the different forms of motivation and adherence.

#### 4.5 | Team sports as a feasible training modality for older adults

This is the first study to show that team sports in a group of very old adults (≈80 years) are feasible. Previously, small-sided football and floorball training have also shown to be feasible and health-promoting activities in healthy recreational active men aged 65–75 years.<sup>15,22</sup> However, compared with the latter two studies, participants in the present study were ≈11 years older (80 vs 69 years) and had a lower physical function (performance in 30-second chair stand ≈13 vs 18 repetitions). In the present study, the team sports training differed in a number of ways compared with traditional team sports. First, the training was organized as small interval games separated by recovery sessions instead of a continuous game of longer duration. Secondly, the training was performed 3 vs 3 on small-sided areas (≈10 × 10 m) in contrast to larger areas with multiple participants. This organization of small-sided team sport training may have been advantageous compared to traditional team sports organization due to more participant involvement (eg, higher chance of scoring and getting in contact with the ball) and reduced risk of injuries (eg, fewer long sprints and avoiding general fatigue with recovery sessions between intervals), but this warrants further investigations.

#### 4.6 | Limitations of the study

This study has some limitations that should be addressed. The relatively small sample size, combined with the high number of dropouts, has increased the risk of type 2 errors; that is, that changes between groups are not discovered. For example, it is possible that the change in the performance in the “up-and-go” test would have been significant (*P*-value was .055), if more subjects had been included in the study. Also, low questionnaire sensitivity with the elderly population and participant cognitive functioning may have influenced data quality.

The multiple comparison design increases the risk of type 1 errors. However, given that all significant changes between groups were in the hypothesized direction, there is little reason to fear that the study is weakened by type 1 errors.

All in all, as our findings are plausible, we believe that both our questionnaire data and results are valid.

## 4.7 | Summary

The present study demonstrated that team sport training could improve physical function to the same extent as seen in duration-matched resistance training in older adults. In addition, these training interventions did not lead to a lower NEPA; that is, the participants did not compensate for the training with lower levels of daily physical activity, but rather a decrease in sitting time. Importantly, both team sport training and traditional resistance training collectively increased psychological well-being, general quality of life, and health-related quality of life, as well as decreased anxiety and depression. However, team sport training seemed to be more intrinsically motivating than resistance training, mainly due to a higher degree of social connectedness in the team sport training.

## 4.8 | Perspectives and practical applications

As physical activity is important for older adults' physical as well as psychological health,<sup>10</sup> it is important to organize exercise activities that older adults will benefit from. The present study showed that both team sports and resistance training are viable and effective options for this age group. However, future guidelines within the area of physical training among older adults should also put an emphasis on the element of playful team activities, for example, ball games, to increase intrinsic motivation through social connectedness and enjoyment of the activity. Injuries in team sports may be a concern. However, only few injuries were observed despite the intermittent periods of high intensity. A few key practical considerations may have lowered the risk of injuries: (1) proper warm-up, (2) a slow and progressive start-up period, (3) customized rules including few participants playing on small-sided areas, and (4) no physical contact allowed. Furthermore, an interdisciplinary approach, that is, as in the present study, combining physiological, psychological, and social sciences in exercise and health science, may lead to findings that easily can be applied in a real life setting.

## ACKNOWLEDGEMENTS

This study was supported by Nordea-fonden and the Municipality of Copenhagen.

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**How to cite this article:** Pedersen MT, Vorup J, Nistrup A, et al. Effect of team sports and resistance training on physical function, quality of life, and motivation in older adults. *Scand J Med Sci Sports*. 2017;00:1–13. doi:10.1111/sms.12823.