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Research Article

Physical Function Following a Long-Term Lifestyle Intervention Among Middle Aged and Older Adults With Type 2 Diabetes: The Look AHEAD Study

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Abstract

Background: Lifestyle interventions have been shown to improve physical function over the short term; however, whether these benefits are sustainable is unknown. The long-term effects of an intensive lifestyle intervention (ILI) on physical function were assessed using a randomized post-test design in the Look AHEAD trial.

Methods: Overweight and obese (body mass index ≥ 25 kg/m^2) middle-aged and older adults (aged 45–76 years at enrollment) with type 2 diabetes enrolled in Look AHEAD, a trial evaluating an ILI designed to achieve weight loss through caloric restriction and increased physical activity compared to diabetes support and education (DSE), underwent standardized assessments of performance-based physical function including a 4- and 400-m walk, lower extremity physical performance (expanded Short Physical Performance Battery, $SPPB_{exp}$), and grip strength approximately 11 years postrandomization and 1.5 years after the intervention was stopped (n = 3,783).
Results: Individuals randomized to ILI had lower odds of slow gait speed (<0.8 m/s) compared to those randomized to DSE (adjusted OR [95% CI]: 0.84 [0.71 to 0.99]). Individuals randomized to ILI also had faster gait speed over 4- and 400-m (adjusted mean difference [95% CI]: 0.019 [0.007 to 0.031] m/s, p = .002, and 0.023 [0.012 to 0.034] m/sec, p < .0001, respectively) and higher $SPPB_{exp}$ scores (0.037 [0.011 to 0.063], p = .005) compared to those randomized to DSE. The intervention effect was slightly larger for $SPPB_{exp}$ scores among older versus younger participants (0.081 [0.038 to 0.124] vs 0.013 [−0.021 to 0.047], p = .01).
Conclusions: An intensive lifestyle intervention has modest but significant long-term benefits on physical function in overweight and obese middle-aged and older adults with type 2 diabetes.
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Keywords: Diabetes, Weight loss, Physical function, Mobility

Limitations in physical function predict future disability resulting in dependency and greater healthcare costs, morbidity, and mortality (1,2). Obesity is a strong predictor of limitations in physical function, operating through both direct (eg, biomechanical changes) and indirect (eg, obesity-related comorbidities) pathways (3,4). Type 2 diabetes further accelerates declines in physical function and increases the risk of disability (5,6).

Lifestyle interventions have been shown to improve physical function over the short term. In middle aged and older adults who were overweight or obese, participation in weight loss and exercise interventions lasting up to 18 months improved performance-based physical function measures (7–12). In the Look AHEAD trial, overweight or obese middle aged and older adults with type 2 diabetes randomized to an intensive lifestyle intervention for weight loss had slower declines in self-reported physical function over 4 and 8 years of follow-up compared to those randomized to a diabetes support and education control (13,14). However, reductions in skeletal muscle mass that accompany weight loss may lead to muscle weakness (15), resulting in impaired physical function and disability (16). Thus, whether potential benefits of lifestyle change on performance-based physical function are sustainable over the long-term is unknown.

This study examined the effect of a long-term intensive lifestyle intervention (ILI) designed to achieve and maintain weight loss through caloric restriction and increased physical activity in middle-aged and older overweight and obese adults with diabetes on performance-based measures of physical function assessed approximately 11 years after randomization compared to a diabetes support and education (DSE) control group in Look AHEAD. We hypothesized that individuals randomized to ILI would have better performance-based physical function 11 years postrandomization compared to DSE. The consistency of the findings was also examined in pre-specified subgroups defined according to baseline age, gender, and body mass index (BMI).

Methods and Procedures

Look AHEAD was a multi-center, randomized controlled trial designed to test the effects of an intensive lifestyle intervention designed to achieve and maintain a 7% weight loss on cardiovascular morbidity and mortality (17). In brief, Look AHEAD recruited 5,145 individuals with type 2 diabetes between August 2001 and April 2004 who were 45–76 years of age and had a BMI ≥25 kg/m^2 (≥27 kg/m^2 if on insulin), HbA_{1c} <11%, systolic blood pressure <160 mmHg, diastolic blood pressure <100 mmHg, and triglycerides <600 mg/dl.

Intervention

At enrollment into the Look AHEAD trial, participants were randomly assigned by center to an intensive lifestyle intervention (ILI) or a Diabetes Support and Education (DSE) control condition. ILI participants were given an individual weight loss goal of ≥10% and physical activity goal of ≥50 min/wk in the first month and ≥175 min/wk by the end of 6 months (18). In Phase 1, ILI participants were seen weekly for the first 6 months and three times per month for the next 6 months using a combination of group and individual sessions. In Phase II (Years 2–4), participants had one in-person individual session and a minimum of one additional contact by phone, mail or email per month with a goal of weight maintenance or reversal of weight regain. In Phase III (Years 5+), participants were encouraged to continue individual monthly sessions (a minimum of two individual sessions per year were required) and refresher campaigns with a goal of prevention of weight regain. DSE participants were invited to three group sessions focused on diet, physical activity, or social support each year for the first 4 years and one session annually thereafter (19). DSE participants did not receive information on behavioral strategies.

Acting on the recommendation of the trial's Data and Safety Monitoring Board, the intervention was stopped due to futility on September 14, 2012 (20). At that time, participants had been in the intervention for up to 11 years (median 9.6 years). All Look AHEAD participants who were alive when the intervention was stopped were invited to join a follow-up observational study to determine the longer term effects of the intervention on a number of outcomes.

Physical Function Measures

The Look AHEAD study assessed performance-based physical function at all sites between August 2013 and December 2014, approximately 11.4 years (range, 9.5–13.2 years) after randomization and 1.6 years (range, 1.0–2.3 years) after the intervention was stopped. Clinic staff masked to intervention assignment conducted all physical function measures following centralized training and certification.

The Short Physical Performance Battery (SPPB) was administered to assess lower extremity physical function (21). The SPPB consists of standing balance tasks (ability to stand with the feet together in side-by-side, semi- and full-tandem positions for 10 s each), a 4-m walk to assess usual gait speed, and time to complete 5 repeated chair stands. Each of the three performance measures is assigned a score ranging from 0 (inability to perform the task) to 4 (the highest level of performance) and summed to create an SPPB score ranging from 0

to 12 (best). The SPPB was modestly expanded ($SPPB_{exp}$) to minimize ceiling effects of the SPPB when used in well-functioning populations by increasing the holding time of the standing balance tasks to 30 s and adding a single leg stand (22). The $SPPB_{exp}$ component scores are calculated as the ratio of observed performance to the best possible performance and summed to provide a continuous score ranging from 0 to 3 (higher scores indicative of better performance).

Usual gait speed over 400 m was measured on a 20-m course (23); due to insufficient space, four clinics used a 10-m course. Participants were instructed to walk at their usual pace and time to complete the 400-m walk was recorded. Participants who were wheelchair-bound or dependent on a walker or quad cane, had a cardiovascular disease (CVD) event in the past 3 months, or whose blood pressure was >170/100 mmHg were excluded from testing. 400-m gait speed was calculated for those participants who completed the walk (3,026 out of 3,384 who attempted the walk).

Grip strength (kg) was measured twice in each hand using an isometric Hydraulic Hand Dynamometer (Jamar, Bolingbrook, IL). The maximum force from two trials for the stronger hand was used in the analyses.

Mobility disability was adjudicated by committee and defined as definite (unable to complete the 400-m walk in 15 min or less, 4-m gait speed <0.44 m/s if the 400-m walk was not attempted, wheelchair/walker/quad cane dependent, or self-report of being unable to walk in past 4 weeks; n = 497), probable (4-m gait speed ≥0.44 but <0.8 m/s if the 400-m walk was not attempted or if neither the 400-m nor the 4-m walk was attempted due to safety concerns; n = 108), possible (400-m walk not attempted due to pain or cardiovascular or orthopedic contraindications; n = 127), or absent (400-m walk completed in less than 15 min; n = 3,014). Mobility limitation was undeterminable in 85 participants. Three separate mobility disability definitions were examined: (a) definite disability versus no, probable, possible disability, or dead; (b) definite disability or dead versus no, probable, or possible disability; (c) probable, possible, definite disability, or dead versus no disability. Participants were also classified as having slow gait speed (4-m gait speed < 0.8 m/s), impaired lower extremity function (SPPB score ≤ 9), and impaired grip strength (<26 kg in men, <16 kg in women).

Potential Risk Factors for Physical Limitations

Self-reported characteristics and conditions were assessed using standardized questionnaires at baseline. A maximal graded exercise test was administered and cardiorespiratory fitness estimated in metabolic equivalents (METS) (24). The 36-item Short Form Health Survey (SF-36), which measures eight health domains including physical functioning, was used as a measure of health status, with domain subscale scores ranging from 0 to 100 (higher scores indicating better functioning or well-being) (25). Height was measured in duplicate using a stadiometer. Clinic staff masked to intervention assignment collected annual measures of weight throughout the trial using a digital scale. The Paffenbarger Physical Activity Index was collected in a subset of participants at baseline and Year 1 and 4 and in all participants at Year 8 and the observational follow-up visit (26).

Statistical Analyses

Unadjusted comparisons between groups were done using chi-square tests for proportions and t-tests or ANOVA for continuous variables measured at baseline and follow-up. Logistic regression was used to compare categorical physical performance measures and analysis of covariance (ANCOVA) was used to compare continuous physical performance measures among intervention groups adjusted for age, gender, race/ethnicity, clinic site, and baseline BMI, CVD history, and SF-36 Physical Functioning score. To account for selection bias potentially caused by dropout, death and missing outcomes, the conditional probability to be included in the analysis sample for all randomized participants was calculated based on their baseline characteristics (age, gender, race/ethnicity, clinic site, and baseline BMI, HbA1c %, hypertension, CVD history, cardiorespiratory fitness, and SF-36 physical functioning score). Then a sensitivity analysis was performed that included the calculated conditional probability as an additional covariate in the logistic regression or ANCOVA models described above. The consistency of the intervention effect on each outcome across pre-specified subgroups defined by baseline age (<60 vs ≥60 years), gender, and BMI (< 30 vs ≥30 kg/m^2) was examined by adding intervention group by subgroup interactions to the adjusted models and examining the effect across subgroups when p for interaction was <0.10. All analyses were performed in SAS 9.4 (Cary, NC).

Results

At baseline (2001–2004), 5,145 participants were randomized to either ILI (n = 2,570) or DSE (n = 2,575) in the Look AHEAD trial. Of those, 4,033 were still active approximately 11 years after randomization and 1.5 years after the intervention ended; 524 were deceased; and 588 had dropped out. Of the 4,033 active participants, 3,979 consented to continued follow-up and 3,783 (95%) had at least one physical function measure; 74% of those originally randomized in the Look AHEAD trial.

Participants with physical function data who were included in these analyses (n = 3,783) were younger (58.1 vs 60.4 years, p < .0001); less likely to be male (39% vs 45%, p < .0001) or have a history of cardiovascular disease (12% vs 20%, p < .0001) at baseline; were more likely to be African American (16% vs 13%, p < .0001); had a lower baseline BMI (35.8 vs 36.3 kg/m^2, p = .02); and had higher baseline cardiorespiratory fitness (7.3 vs 6.8 METS, p < .0001) compared to the original Look AHEAD participants who were excluded from the analyses due to death, loss-to-follow-up, or lacking all physical function data (n = 1,362). Furthermore, participants included in these analyses had a higher self-reported SF-36 Physical Functioning score at baseline compared to those who were excluded (48.7 vs 47.7, p < .0001). There was no difference in the distribution of intervention assignment between those who had physical performance data and the original Look AHEAD cohort. The risk factor distribution in the analysis sample was balanced between intervention groups (Table 1), except a greater percentage of ILI participants had a cardiorespiratory fitness level ≥7.5 METS (43% vs 40%, p = .02) compared to DSE participants.

The ILI intervention produced substantial differences in weight loss (p < .0001) and physical activity (p < .001) compared to DSE. Differences were largest after the first year of intervention, but remained through the end of the intervention (September 2012) (Figure 1 and 2). ILI participants lost a mean (SE) 8.7% (0.13%) of their weight at Year 1 and maintained a 6.0% (0.2%) mean weight loss through the end of the intervention. In contrast, weight loss in the DSE participants was 0.6% (0.1%) at Year 1 and 3.4% (0.2%) at the end of the intervention. Change in self-reported physical activity from baseline also differed by intervention group at year 1 (mean [SD]: 893.1 [42.6] vs 99.5 [42.5] kcals/wk for ILI vs DSE, p < .0001) and at Year 8 (mean [SD]: 112.9 [39.6] vs –96.0 [39.5] kcals/wk for ILI vs DSE, p = .0002).

The physical function data were collected an average of 11.4 years after randomization (range, 9.5–13.2 years). Table 2 shows the unadjusted frequencies and means of the physical function

Table 1. Characteristics at the Time of Enrollment by Intervention Assignment: The Look AHEAD Study

	Original Randomized Sample		Analytical Sample		
	Intensive Lifestyle Intervention (ILI)	Diabetes Support and Education (DSE)	Intensive Lifestyle Intervention (ILI)	Diabetes Support and Education, DSE)	*p*-Value*
N	2,570	2,575	1,902	1,881	
Age, years	58.6 ± 6.8	58.9 ± 6.9	58.0 ± 6.5	58.3 ± 6.6	.28
≥60 years	1,090 (42.4%)	1,125 (43.7%)	738 (38.8%)	761 (40.5%)	.30
Female gender	1,526 (59.4%)	1,537 (59.7%)	1,152 (60.6%)	1,164 (61.9%)	.41
Race					.95
African American/Black (not Hispanic)	400 (15.6%)	404 (15.7%)	308 (16.2%)	315 (16.7%)	
White	1,621 (63.1%)	1,631 (63.3%)	1,164 (61.2%)	1,152 (61.2%)	
Hispanic	340 (13.2%)	340 (13.2%)	260 (13.7%)	248 (13.2%)	
Other/mixed	208 (8.1%)	200 (7.8%)	170 (8.9%)	166 (8.8%)	
BMI, kg/m^2	35.9 ± 6.0	36.0 ± 5.8	35.7 ± 5.9	36.0 ± 5.8	.08
BMI ≥ 30 kg/m^2	2,167 (84.3%)	2,213 (85.9%)	1,585 (83.3%)	1,605 (85.3%)	.09
Prior cardiovascular disease	365 (14.2%)	347 (13.5%)	236 (12.4%)	204 (10.8%)	.13
Cardiorespiratory fitness, METS	7.2 ± 1.9	7.2 ± 2.0	7.4 ± 2.0	7.3 ± 2.0	.54
SF-36 Physical Functioning Score	48.5 ± 7.8	48.4 ± 8.0	48.7 ± 7.8	48.7 ± 7.8	.96

BMI = body mass index; METS = metabolic equivalent; SF-36 = Short Form Health Survey.
*Mean ± SD or number (%) with *t*-test or chi-square to evaluate the distribution across intervention groups in the analysis sample.

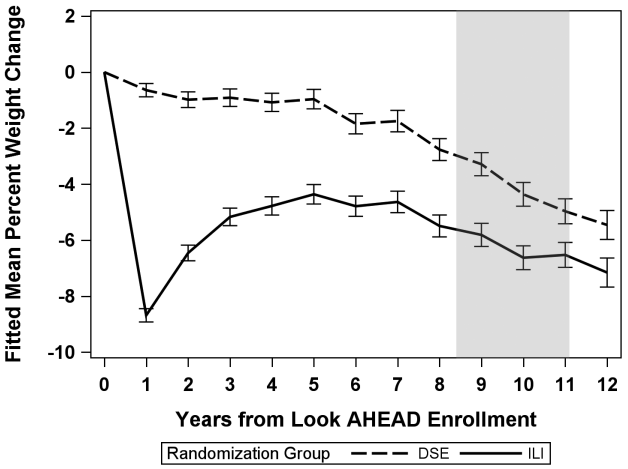

Figure 1. Percent weight change since randomization by intervention group: the Look AHEAD study. Shaded area designates end of the intensive lifestyle intervention which varies depending on enrollment date.

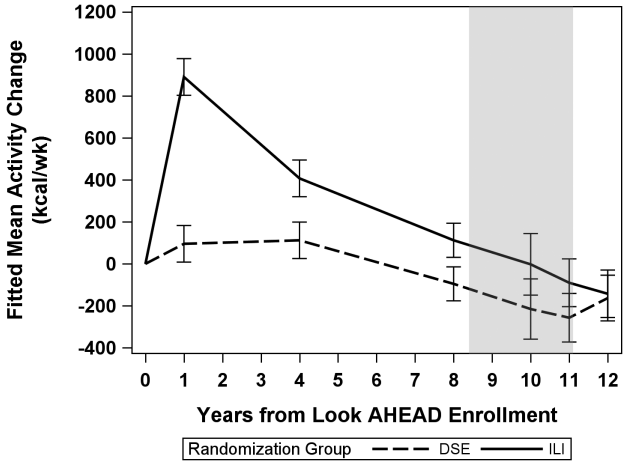

Figure 2. Change in physical activity since randomization by intervention group: the Look AHEAD study. Shaded area designates end of the intensive lifestyle intervention which varies depending on enrollment date.

tests grouped by intervention assignment and the adjusted odds ratios and mean differences (95% CI). In unadjusted analyses, ILI participants had faster 4- and 400-m gait speed and higher $SPPB_{exp}$ scores and a smaller proportion of ILI participants had slow gait speed (<0.8 m/s) compared to DSE participants. After adjusting for age, gender, race/ethnicity, clinic, and baseline SF-36 physical function score, CVD history, and BMI, ILI participants had lower odds of slow gait speed compared to DSE participants; however, there were no associations between intervention assignment and mobility disability or impaired lower extremity function or grip strength. ILI participants also had faster gait speed over 4- and 400-m and higher $SPPB_{exp}$ scores. Results were similar when time to complete the 400-m walk was imputed based on distance and time walked for the 354 participants who were unable to complete the walk (data not shown). To determine whether 4-m gait speed was driving the observed association with $SPPB_{exp}$ score, the other two $SPPB_{exp}$ components were also examined; ILI participants had greater standing balance times and faster chair stand pace (adjusted mean difference [95% CI]: 1.87 [0.33 to 3.41] and 0.007 [0.000 to 0.014] seconds, respectively). Analyses using the conditional probability of being included in the analytical sample to adjust for attrition and nonparticipation yielded similar estimated intervention effects overall and within all subgroups (data not shown).

The intervention effect appeared to vary by baseline age, gender, and BMI for some physical function outcomes (p for interactions < .10); thus, estimates (95% CI) of the associations between the intervention and physical function were obtained for age, gender, and BMI subgroups (Supplementary Tables 1–3). For those who were ≥60 years at randomization, ILI participants had a lower odds of definite mobility disability or death (adjusted OR [95% CI]: 0.80 [0.66 to 0.98]) and impaired lower extremity function (adjusted OR [95% CI]: 0.81 [0.65 to 1.02]) (Figure 3), and higher SPPB (adjusted mean difference [95% CI]: 0.393 [0.161 to 0.625]) and $SPPB_{exp}$ (adjusted mean difference [95% CI]: 0.081 [0.038 to 0.124]) scores (Supplementary

Table 2. Unadjusted Means and Frequencies by Intervention Assignment and Adjusted Odds Ratios (95% CI) or Mean Differences (95% CI) for Physical Function by Treatment Group at 11 Year Follow-Up: The Look AHEAD Study

	Treatment Group						
	ILI		DSE				
Measures of Physical Function	*N*	*N* (%) or Mean ± SD	*N*	*N* (%) or Mean ± SD	Unadjusted Treatment Group *p*-Value	Adjusted* Treatment Group, Odds Ratios or Mean Differences (95% CI)	Adjusted Treatment Group *p*-Value
Mobility disability							
Definite mobility disability	2,134	237 (11.1)	2,137	260 (12.2)	.28	0.96 (0.78 to 1.17)	.66
Definite mobility disability or death	2,134	487 (22.8)	2,137	535 (25.0)	.09	0.92 (0.79 to 1.07)	.28
Definite/probable/possible mobility disability or death	2,134	607 (28.4)	2,137	650 (30.4)	.16	0.95 (0.82 to 1.10)	.50
Slow gait speed (<0.8 m/s)	1,832	386 (21.1)	1,806	441 (24.4)	.02	0.84 (0.71 to 0.99)	.04
Impaired lower extremity function (SPPB ≤9)	1,781	742 (41.7)	1,731	772 (41.7)	.98	1.02 (0.88 to 1.18)	.79
Impaired grip strength (<26 kg men; <16 kg women)	1,761	252 (14.3)	1,732	265 (15.3)	.41	1.08 (0.89 to 1.32)	.43
Gait speed							
4-m gait speed (m/s)	1,832	0.95 ± 0.21	1,806	0.93 ± 0.21	.0008	0.019 (0.007 to 0.031)	.002
400-m gait speed (m/s)†	1,532	1.00 ± 0.19	1,494	0.97 ± 0.19	<.0001	0.023 (0.012 to 0.034)	<.0001
Lower extremity physical performance							
SPPB score (range, 0–12)	1,781	9.4 ± 2.4	1,731	9.3 ± 2.4	.10	0.105 (–0.036 to 0.245)	.14
$SPPB_{exp}$ score (range, 0–3)	1,855	1.50 ± 0.46	1,817	1.46 ± 0.46	.003	0.037 (0.011 to 0.063)	.005
Grip strength (kg)	1,761	27.0 ± 9.9	1,732	26.5 ± 9.7	.14	0.307 (–0.115 to 0.729)	.15

SPPB = short physical performance battery; SPPBexp = expanded short physical performance battery.

*Adjusted for age, gender, race/ethnicity, clinic, and baseline SF-36 physical functioning, cardiovascular disease, and body mass index, and whether or not an alternate (10-m) course was used (400-m gait speed mean difference only). OR: DSE is reference group. Mean differences: ILI–DSE.

†Results shown are for participants who completed the 400-m walk only.

Table 1) than DSE participants; however, there were no significant differences by intervention arm among those <60 years at randomization. For gender, male ILI participants had higher $SPPB_{exp}$ scores compared to male DSE participants (adjusted mean difference [95% CI]: 0.070 [0.028–0.112]; Supplementary Table 2). For those with a BMI <30 kg/m^2 at baseline, ILI participants had a lower odds of slow gait speed compared to DSE participants (adjusted OR [95% CI]: 0.56 [0.35 to 0.90]; Supplementary Table 3).

Discussion

Overweight and obese middle aged and older adults with type 2 diabetes who were randomized to a long-term intensive lifestyle intervention were less likely to have slow gait speed (<0.8 m/s) approximately 11 years postrandomization and 1.5 years after the intervention ended compared to those randomized to a diabetes support and education control group. Individuals randomized to the intervention also had faster gait speed over both short and long distances and better lower extremity function as assessed by a performance-based physical function test. Grip strength, an indicator of general upper body strength, did not differ between the intervention groups, suggesting that weight loss did not lead to declines in strength despite anticipated declines in lean mass. For some physical function outcomes, the intervention effect was slightly larger among older participants in particular.

Previous trials showing performance-based functional benefits of lifestyle interventions in middle aged and older persons who were overweight or obese have been of shorter duration (5–18 months) (7–12). In Look AHEAD with approximately 11 years of follow-up, ILI participants' mean gait speed (at usual pace) was approximately 0.02 m/s better than DSE participants and among those aged 60 years and older at baseline, the SPPB score was approximately 0.4 points higher. These findings are consistent with those observed at the 8-year follow-up in a small subset of the Look AHEAD trial (27). For physical function, differences of 0.03–0.08 m/s in gait speed and 0.3–0.8 points on the SPPB have been reported to represent small albeit clinically meaningful differences (28–30). Furthermore, ILI participants were less likely to have a slow gait speed (<0.8 m/s), which has been associated with increased risk of disability and mortality (31,32), compared to DSE participants.

However, some physicians are reluctant to recommend weight loss in older adults due to concerns regarding the functional consequences of the loss of lean mass (33,34). According to the sarcopenia hypothesis, lower lean mass leads to weakness (16). Body composition was assessed through the 8-year follow-up in four of the Look AHEAD sites (n = 1,019) (35). Weight loss in DSE participants was comprised almost entirely of lean mass. In ILI participants, weight loss was comprised of both fat and lean mass with ILI participants having significantly lower lean mass at 8-year follow-up than DSE participants; there was, however, no significant interaction with age. Nevertheless, for several of the performance-based physical function measures, there appeared to be a benefit among older (≥60 years at baseline), but not younger, ILI participants compared to DSE participants. No differences in upper extremity strength were observed between ILI and DSE participants in either the younger or older subgroups. The lack of an association between changes in lean mass and strength has also been observed in other short-term weight loss trials (36,37).

This study has notable strengths and limitations. Although these analyses are based on a post-test design, the comparisons are based on randomization assignment, thereby accounting for potential unmeasured confounders between the groups. Retention approximately 11 years post-randomization was excellent, exceeding 80% of the original sample. Although losses to follow-up were associated with predictors of impaired physical function at baseline, sensitivity analyses applying statistical techniques to account for

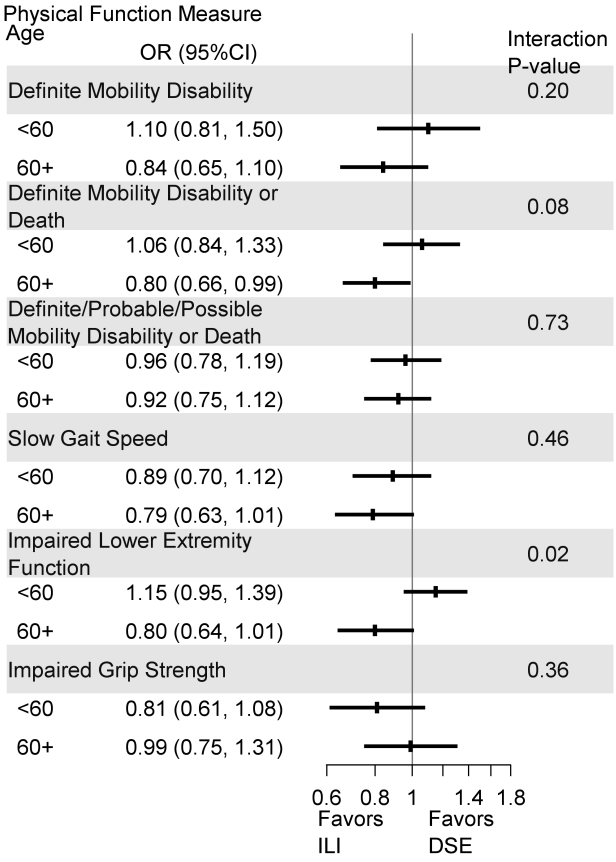

Figure 3. Forest plot of mobility disability, slow gait speed, and impaired lower extremity function and grip strength by age and intervention assignment: the Look AHEAD study. Adjusted for gender, race/ethnicity, clinic, and baseline SF-36 physical functioning, cardiovascular disease, and body mass index.

differential participation based on baseline characteristics provided similar results. However, since the analyses are based on those who returned for the observational follow-up visit, this should not be considered an intention-to-treat analysis. Furthermore, multiple comparisons were made on several measures of physical function which may increase the probability of Type I error, thus, caution should be used when interpreting the *p*-values. The intervention was successful in achieving sustained long-term weight loss in a substantial proportion of participants providing a unique opportunity to examine the long-term benefits of randomization to weight loss on physical function. DSE participants also lost weight over the latter part of the trial which may have attenuated differences observed in physical function. Intentionality of weight loss was not assessed, however. While the intervention was also successful in increasing physical activity in the early phases of the trial, group differences in change in physical activity had diminished by the observational follow-up visit. Physical function was only measured postrandomization and not at baseline so the extent to which change in weight was associated with change in physical function cannot be assessed. Furthermore, had physical function been measured earlier in the study when there was greater separation of weight loss between the two groups, greater differences in physical function may have been observed. As eligible volunteers for the Look AHEAD trial, these results may not be generalizable to other overweight or obese populations without diabetes.

In conclusion, overweight and obese middle aged and older adults with diabetes who were randomized to a long-term intensive lifestyle intervention for weight loss were less likely to have slow gait speed and had small, albeit significant, benefits in gait speed and lower extremity function approximately 11 years later and 1.5 years after the intervention ended. Differences in upper body strength were not observed between the randomized groups. Thus, despite the anticipated declines in lean mass with weight loss, physical function was not negatively impacted. Intentional weight loss through dietary modification and increased physical activity may be useful in preventing or delaying the onset of impaired physical function and mobility disability in overweight and obese middle aged and older individuals with type 2 diabetes.

Supplementary Material

Supplementary data is available at *The Journals of Gerontology, Series A: Biological Sciences and Medical Sciences* online.

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Conflict of Interest Statement

None declared.

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