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Meeting Physical Activity Guidelines and Musculoskeletal Injury: The WIN Study

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Abstract

Introduction—The United States Department of Health and Human Services disseminated physical activity guidelines for Americans in 2008. The guidelines are based on appropriate quantities of moderate-to-vigorous aerobic physical activity and resistance exercise associated with decreased morbidity and mortality risk and increased health benefits. However, increases in physical activity levels are associated with increased risk of musculoskeletal injuries. We related the amount and type of physical activity conducted on a weekly basis with the risk of musculoskeletal injury.

Methods—Prospective, observational study using weekly Internet tracking of moderate-to-vigorous physical activity and resistance exercise behaviors and musculoskeletal injuries in 909 community-dwelling women for up to 3 years. Primary outcome was self-reported musculoskeletal injuries (total, physical activity-related, and non physical activity-related) interrupting typical daily work and/or exercise behaviors for ≥2 days or necessitating health care provider visit.

Results—Meeting versus not meeting physical activity guidelines was associated with more musculoskeletal injuries during physical activity (hazard ratio [HR] = 1.39, 95% confidence interval [CI] = 1.05 – 1.85, $P = 0.02$), but was not associated with musculoskeletal injuries unrelated to physical activity (HR = 0.99, 95% CI = 0.75 – 1.29, $P = 0.92$), or with musculoskeletal injuries overall (HR = 1.15, 95% CI = 0.95 – 1.39, $P = 0.14$).

Conclusions—Results illustrate the risk of musculoskeletal injury with physical activity. Musculoskeletal injury risk rises with increasing physical activity. Despite this modest increase in musculoskeletal injuries, the known benefits of aerobic and resistance physical activities should not hinder physicians from encouraging patients to meet current physical activity guidelines for both moderate-to-vigorous exercise and resistance exercise behaviors with the intent of achieving health benefits.

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Keywords

MODERATE; PREVALENCE; STRENGTHENING; VIGOROUS

Evidence supports the relation between physical activity (PA), energy expenditure, physical fitness, and health outcomes (29,31). Additionally, as obesity and its complications are increasing in the United States (9,14), the emphasis on PA to improve fitness and weight management for health reasons increases. The American College of Sports Medicine initiated "*Exercise Is Medicine*," a campaign "calling on all health care providers to assess and review every patient's PA program at every visit." The goal is to encourage physicians to make PA and exercise a standard part of disease prevention and medical treatment. Physicians recommending PA to their patients appear to improve initiation and compliance with an exercise program (11). National PA guidelines (PAGs) were developed in 2008 which recommend ≥150 minutes of moderate-to-vigorous aerobic activity (MVPA) per week and ≥2 resistance exercise (RE) sessions per week to achieve health benefits (35). Additional health benefits are observed with increasing amounts of PA (i.e., ≥300 minutes of MVPA per week) (35). Combinations of moderate and vigorous PA are accomplished with 1 minute of vigorous PA equating to 2 minutes of moderate PA. Evidence of the importance of PA's impact on health is the inclusion of PA objectives in *Healthy People 2020* (4). While the PAGs indicate the benefits of PA, they also illustrate the potential of increased musculoskeletal injuries (MSI) for those engaging in PA (29). Adverse events generally increase with the amount of PA engagement. The PAGs Committee Report Figure G10-1 suggests a linear increase in MSI with increased mileage or MET-minutes per week of PA for recreational runners and walkers (29). Reported prevalence of injuries range from <10% to ≈40% with a median of approximately 20% (7,13,17,23,27,32) in recreational runners and walkers. MSI studies have been conducted on sport participants (5) and military personnel (15,16,20). We identified no studies in general community-dwelling individuals or settings addressing the risk of MSI when conducting PA sufficient for health benefits as defined by the U.S. Department of Health and Human Services' PAG (35). Interest lies in MSI occurrence for individuals meeting the 2008 PAGs.

Reports relating MSI to PA generally use historical recall of injury. Military studies of injury have been conducted with medical records, concurrent training logs, and objective measures of injury and PA (1,21,22). Our objective was to obtain concurrent real time PA and MSI. The Women's Injury (WIN) Study is a 5-year prospective observational study designed to determine the incidence and predictors of MSI in a cohort of community-dwelling women during which participants reported PA behaviors and MSI weekly via a secure website for up to 3 years. The purpose of the current analysis was to relate PA sufficient for meeting PAG to the risk of MSI.

METHODS

Study population

Women ≥20 years were recruited from the general population in the Dallas, TX area. The recruitment database consisting of women who had previously contacted the research center about inclusion in studies or who had been involved in other center studies/activities was initially used. Additional recruitment strategies included radio announcements, featured newspaper stories, word of mouth, health fair presentations at predominantly black churches, and announcements distributed via listings generated from health fair attendance. Our goal was to recruit 25% minority participation.

Inclusion criteria were 1) no significant disease or condition that precluded doing usual daily, occupational, or recreational activities, 2) access to a computer with Internet connection and skills to routinely enter data, and 3) no plans to leave the area for 2+ years. Women were excluded if they had 1) any major diseases or musculoskeletal conditions that interfered with mobility or usual activities of daily living or 2) needed an assistive device to ambulate. Study procedures were approved annually by The Cooper Institute's Institutional Review Board.

Study process

After completion of initial eligibility screening, participants attended an orientation session where they received study details and completed informed consent. Recruitment began in year 1 and continued for the next 1.5 years until we reached our goal of a minimum of 885 participants. General structure of the study included an ongoing PA and MSI surveillance program commencing at the point of completion of baseline instruments through the end of data collection, at the end of the 4th year of the study. Baseline evaluations included demographic data, medical and orthopedic history, history of injury, and an orthopedic examination by physical therapists. Demographic data and medical and orthopedic history were obtained with on-line questionnaires. Measured height and weight were used to obtain BMI. Percent body fat was estimated from 3 skinfolds (19). Study details are reported elsewhere (2).

Website surveillance

Participants responded weekly to, "Did you have an injury (new, old, or recurrent) this week that caused you to see a health care provider or interrupted your daily activities for 2 or more days?" Study personnel confirmed if the injury was a MSI during a follow-up telephone call, typically within 48 hours of reported injury. Participants also utilized the Internet to enter information on moderate aerobic PA, vigorous aerobic PA, and muscle strengthening/resistance exercise activities in the previous week. Participants were provided paper PA logs in case they could not complete the on-line version. The PA questions were based on the CDC's 2005 Behavioral Risk Factor Surveillance System of PA/exercise questioning. Moderate activities included but were not limited to brisk walking, bicycling, vacuuming, gardening, or any PA causing small increases in breathing or heart rate and would not make one strain. Vigorous activities included but were not limited to running, aerobics, heavy yard work, or any PA causing large increases in breathing or heart rate and would eventually make one strain. Participants indicating involvement in PA reported days per week and minutes per day. Based on the 2008 PAG (35), we calculated total MVPA by adding the number of moderate PA minutes to 2 times the number of vigorous PA minutes per week. To obtain "real-time" and concurrent measures, the log-in window was available Saturday 1800 hrs until 2400 Monday each week.

Participant retention

Strategies were utilized to enhance retention. Weekly staff meetings identified participants completing PA logs <3 times in the preceding 4-week period. Telephone contact was made with those individuals and problem solving strategies including Motivational Interviewing (26) were used to encourage participation. Participants not reporting on-line were provided the opportunity to submit paper reports if they were available. Written reports had to be submitted within a reasonable time (e.g., typically <3–4 weeks). Participants received monetary rewards dependent on compliance with the activity log submission either online or on paper during the preceding 4-week period. Participants received $60 per 24-week period (i.e., $10 for reporting ≥3 times in the 4-week period) and an extra $100 if they reported 75% of all enrolled weeks at the end of data collection. Additional incentives included access to health information/messages, weekly report information on the website, a quarterly newsletter, seminars on women's health, educational books, and other materials (e.g., pedometers, t-shirts, tote bags, and water bottles).

Injury surveillance

An injury surveillance team queried the database weekly for all self-reported injuries for the previous weekend log-in period. For a participant reporting injury in the preceding week, a follow-up call was made within 48 hours to determine specific details, including confirming if the injury was an MSI, how the injury occurred, body location, need to see a health care provider, and injury treatments. An MSI was considered PA-related if the participant self-reported it occurred *during* PA. If medical care was sought, physician contact information was obtained and efforts made to obtain protected health information related to the injury with the patient's consent. After the initial injury contact, participants were contacted weekly until the injured participant reported returning to usual life activities. Three telephone attempts were made to obtain participant MSI follow-up information and then e-mail contact was attempted. MSI information was entered into an injury surveillance table.

Reported PA-related MSI could be acute injury or acute exacerbation of an underlying chronic musculoskeletal condition. Physician review of obtainable medical records (≈50%) further clarified and validated the medical diagnosis of the self-reported MSI events.

Statistical analyses

The primary data consist of weekly activity and injury reports from each participant. The data are interval censored by week. In general, there may be multiple incident injuries per individual. We analyzed all MSI, PA-related MSI, and non PA-related MSI. We stratified all analyses by presence or absence of previous injury. Presence or absence of previous injury at study entry was available from the baseline survey. Individuals who reported no injuries prior to the study who then suffered an MSI during the study were counted in the previously injured stratum for the duration of the study. We calculated incidence rates by dividing the number of injuries by the number of weeks observed. We modeled injuries using a recurrent events proportional hazards model, using attained age as the time scale, and the robust covariance estimate aggregated over all records of the same individual to account for correlation among recurrent events (25). We tested the primary hypothesis by entering time-dependent PA and RE behavior as PAGs categorical covariates in a recurrent events model. The time-dependent PAG level for predicting injury in the current week was determined by averaging reported activity history from the previous injury week (or baseline if none reported) to the prior week. We tested whether PA effects varied significantly across RE levels and whether hazard ratios varied significantly across previous injury strata. Sensitivity analyses were conducted by eliminating (1) weeks and (2) participants reporting MVPA minutes >99th percentile. We used SAS/STAT® 9.2 (Cary, NC) for all hypothesis testing and model estimation.

RESULTS

Nine hundred and eighteen participants entered the long term phase of the WIN Study. We report here on 909 of 918 participants. Nine participants were not included in the analyses because they completed all study preliminary phases and began the long term phase yet provided no PA weekly reports. The average participant was enrolled for 98 weeks and the average number of weeks of reports submitted was 91. At the conclusion of data collection, 731 (80%) remained involved. Greater than 95% of 731 participants received the final $100 incentive for completing at least 75% of their weekly reports. The 909 women self-reported a total of 83,241 weeks of PA. Our goal of 25% minority enrollment was achieved. Baseline characteristics and PA behaviors are reported in Table 1 by average amount of PA conducted. Housework and walking were the most frequently reported PA conducted ≥2 days per week at baseline. Most participants (n= 498; 55%) reported no MSI. Of those injured, 251 (61%) reported a single injury, and 353 (86%) reported no more than two injuries. About an equal number of MSIs were reported during PA and not during PA. The majority of MSIs involved the lower extremities. MSI causes are reported in Table 2; 40% of self-reported MSIs occurred without a specific inciting event while exercising and worsened with the activity and 31% came on suddenly with no apparent cause. First self-reported MSI during PA was typically related to walking, jogging/running, or weight lifting. The location of the vast majority (66.3%) of the sustained first injuries was the lower body and/or lower extremity. Seventy percent of all MSIs resulted in the participant seeing a health care provider. Participants seeking health care for PA-related injuries were 61.7%, 83.5%, and 43.3% for below, meeting, and exceeding PAGs, an indication that seeking health care was related to reported PA level.

History of previous reported MSI was obtained at study entry. Previous MSI, consistent with MSI tracking, was defined as an injury resulting in disruption of usual activities at home, at work, or during leisure time for ≥2 days or requiring medical intervention. A participant responding yes to injury of any of 17 body parts was indicated to have a previous injury. Initial analyses indicated previous MSI was related to subsequent reporting of MSI during PA. Thus, analyses were conducted with two strata based on previous injury history. Injury rates are presented in Table 3 for MVPA categories by previous injury strata. Rates varied by amount of PA and for type of MSI (total, PA-related, non PA-related MSI). Rates are higher for those with a previously reported injury regardless of the type of PA reported.

Hazard ratios (HR) are presented in Table 4. All and non-PA-related MSI risk did not vary as a function of PA. PA-related MSI increased by 44% for those meeting the ≥150-minute PAGs and 66% for those exceeding the ≥300-minute PAGs relative to those not meeting PAGs. However, when contrasted with those meeting the 150-minute PAGs (referent), those exceeding the 300-minute PAGs were not statistically different. There was no increase in MSI for those achieving the RE PAGs of ≥2 days per week. HRs did not vary by previous injury strata. Thus, one HR applies equally well for each strata of previous injury. Sensitivity analysis omitting PA behaviors >99% did not substantively change the results. The estimated baseline hazard function for PA-related injuries exhibited no trend with attained age.

We conducted follow-up analyses with 3 BMI categories (<18.5; 18.5 to <25; ≥25 kg/m^2) to determine if PA-related MSI risk was associated with BMI, possibly in combination with previous MSI and/or PA level. Knowing if MSI risk is associated with BMI can help physicians and individuals modify PA behaviors if necessary and provide guidance for future development of PAG. Results indicated a significant PA effect ($P < .006$) and a significant BMI by previous injury interaction ($P < .0001$). Table 5 contains the HR for this analysis. Being underweight with no previous MSI was indicated to be protective against PA-related MSI. However, the small sample size in this subgroup made the HR estimate unreliable. There is a tendency for those with a previous MSI who are overweight / obese to be at reduced risk of PA-related MSI when contrasted with normal weight BMI women.

DISCUSSION

This study is the first prospective investigation of community-dwelling women who routinely reported MSIs suffered while conducting their self-selected PA over the study period. Importantly, both MSIs and self-reported PA behaviors were concurrently measured in near real time. The incidence of all MSI was 38.7% per year, 18.9% per year for PA-related, and 19.8% per year for non-PA-related. Results (see Table 4) show that women who meet the PAGs for MVPA were at increased risk of PA-related MSI. Those who did ≥300 minutes per week may be at increased risk for overall MSI compared to those who failed to achieve the PAGs. Table 4 shows that meeting the RE PAG did not elevate risk compared to not meeting the RE PAG. Also, meeting the RE PAG did not modify the risk associated with the aerobic MVPA guidelines (data not shown). Also evident in Table 4 is that non-PA-related and total MSI were unrelated to aerobic PA behaviors.

Previous studies show an increased incidence of MSI with a history of MSI, increased exposure time, smoking history, and low fitness levels (7,8,18,36). In our cohort, increased MSI risk is most highly correlated with previous MSI and increased amounts of PA. Age was previously found to be related to MSI, with younger individuals sustaining more injuries (8,28,32). We failed to identify such a relation. The age groups previously identified to be most associated with MSI risk were the upper teens and 20s; this was felt to be related to riskier behavior and increased risk exposure (8,28,32). Our youngest participant was age 20 (median age = 52). Another possible cause for the different results in our data was that previous research dealt primarily with sport-related injuries. Given the very low prevalence of smoking behavior in our cohort (3%), smoking status was not included in this analysis.

The particular PA chosen may impact the injury risk as an increased risk of injury in runners with prolonged exercise but not walkers has been reported (7). Type of sport involvement historically has been an important risk factor for injuries. A significant difference exists between contact and non-contact sports (36). Injury rate was found to be as low as 0.9 % in cyclists (30), while team sports such as basketball, football, and soccer lead the way with significantly higher rates (13,28). Research suggests athletes are more likely to be injured during game play than during practice (28). The total low to moderate intensity activity-related injury incidences tends to be higher in an active group due to the large population that participates in PAs including walking, gardening, and yard work (30). This held true in our participants with 26.3% of all first reported injuries occurring while walking. It is important to note that at baseline 82.3% of the cohort reported walking (includes treadmill walking) for transportation, health, or exercise, while the closest frequency of other common athletic activities was 42.6% for resistance exercises and 42.8% for stretching activities.

Similar to other work, most first reported MSIs were to the lower body and/or lower extremity. In prior studies evaluating injury in runners, the lower extremity is the most commonly injured body part in PA-related trauma (8,17,18,32). Leg injuries are prevalent with sprain, strain, or torn knee and ankle ligaments accounting for a large portion of self-reported injuries (30). Of note, head injuries, which are often significant in nature, were quite rare in the group meeting PAGs (1.3%). With respect to specific mechanism of injury, MSIs generally came on gradually and worsened with activity or came on suddenly with no apparent reason (see Table 2). Colliding, tripping, or falling was the third most often reported injury mechanism.

More participants not meeting PAG (61.7%) or meeting PAG (83.5%) sought health care than those exceeding the PAG (43.3%). This indicates that seeking health care was related to reported PA level. Prior studies have shown variability in need for medical attention and hospitalization that appears based on type of sport and intensity of the activity (8,10,30). It is interesting that the most active were the least likely to visit a health care professional. A possibility is that since these women are the most active, they are more likely to have sustained an MSI and chose not to seek health care because of the nature and experiences related to the current or previous MSI.

The prompt injury reporting (within 1 week) via the web-based reporting system is a strong point of this study, which enhances the validity of the patient report. Most prior research was based on population studies, retrospective reports of >2 weeks, or hospital records (8,10,13,30,32). Therefore, the current rates are likely to be valid for a community-dwelling population of women. Additionally, an effort was made to obtain health care provider records on all participants sustaining injuries to more accurately define the injury and events surrounding it. The sample size (N = 909) and the large number of total weeks of PA surveillance (83,241) are study strengths. Another strength of the study is the high retention rate which resulted from participant motivation and an active incentive program.

While the implications for the research are important for recommending PA behaviors, there are limitations to the current research. We have only investigated MSIs in community-dwelling women, thus results cannot be generalized to men. Further work is necessary to determine if the results apply to men. A limitation is that all MSIs are initially self-reported; regardless, the participant did self-report the injury as PA-related and these were subsequently verified via telephone. Additionally, it is possible that a chronic injury or condition was exacerbated by PA or simply occurred as a result of disease progression. Lastly, participation was incentivized which may have altered behavior and hence, outcomes.

In conclusion, the WIN Study provides evidence that following the 150 min/week MVPA as recommended by the 2008 PAGs (35) is associated with an increase in PA-related MSI in women. Further increased aerobic PA (≥300 min per week) results in higher rates of PA-related MSI compared to those not meeting PAGs. Thus, meeting (≥150 min) or exceeding (≥300 min) the PAG results in increased MSI risk. Once meeting the PAG, the MSI risk did not increase significantly when exceeding the PAG. Importantly, non-PA-related MSI and all MSI were not associated with differences in aerobic PA behaviors. Further investigation is warranted for the relation between BMI and MSI. This report can serve to assist health care providers in educating patients about the relative safety of exercise given the known benefits of aerobic PA including decreased all-cause and cardiovascular mortality, coronary heart disease, diabetes mellitus, certain cancers, and psychological benefits (3,12,24,33,34,37). Church et al. (6) recently showed improved diabetes control in study participants who followed a combination regimen of aerobic and strength training as recommended by the 2008 PAGs when compared to non-exercisers. Church et al. provide evidence of the health benefits of meeting the PAGs and our work provides evidence of the relative safety of meeting the PAGs. Sattelmair et al. (31) illustrate the validity of the PAGs with evidence that some activity is beneficial and that more activity results in additional health benefits. Patients can be informed that meeting the PAG (≥150 min/week) results in increased health outcomes but there are increased risks of PA-related MSI associated with differences in overall PA levels. However, PA behaviors are not associated with overall and non-PA-related MSI. Health care providers should stress to patients the importance of participating in both strength and aerobic activities to achieve health benefits. One should not be dissuaded from regular moderate to vigorous exercise based on the relative number and degree of severity of injuries reported here. Rather, the risk of MSI seems low when contrasted to the overall beneficial health outcomes resulting from engaging in sufficient physical activity behaviors.

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TABLE 1

Participant characteristics by physical activity guidelines category, The WIN Study.

	Below Guidelines[a]	Meets Guidelines	Exceeds Guidelines	All
N	411	244	254	909
Baseline measures				
Age	53.4 ±12.5	51.4 ±12.2	52.7 ±12.9	52.7 ±12.5
Body mass index (kg/m^2)	29.1 ±6.7	26.7 ±5.5	26.0 ±5.5	27.6 ±6.2
Body fat (%)[b]	34.1 ±7.2	31.2 ±7.5	29.4 ±7.6	32.0 ±7.7
Current smoker (%)	2.2	3.3	2.4	2.5
Married or living with partner (%)	60.3	66.8	63.8	63.0
Education (yr)	15.9 ±2.3	16.1 ±2.4	16.2 ±2.5	16.0 ±2.4
Currently employed (%)	71.3	69.3	61.4	68.0
Health insurance coverage (%)	93.9	93.9	92.1	93.4
Previously injured (%)	73.7	79.1	79.5	76.8
Physical activity behaviors				
Mean number of weeks reported	101.6 ±35.2	94.8 ±33.7	92.9 ±37.4	97.3 ±35.6
Moderate to vigorous physical activity (min/wk)	71.5 ±44.1	212.3 ±43.1	598.0 ±458.2	256.4 ±329.4
Moderate physical activity (min/wk)	48.6 ±32.3	112.8 ±51.6	266.3 ±299.6	126.7 ±185.6
Vigorous physical activity (min/wk)	11.5 ±13.2	49.8 ±28.0	165.8 ±127.9	64.9 ±95.1
Resistance exercise (days/wk)	0.4 ±0.7	1.0 ±0.9	1.7 ±1.3	0.9 ±1.1
Meets resistance exercise Guidelines (%)	4.1	12.3	35.8	15.2

[a] Below Guidelines (31) is <150 moderate to vigorous physical activity min/week; Meets Guidelines = 150–299 moderate to vigorous physical activity min/wk; Exceeds Guidelines is ≥300 moderate to vigorous physical activity min/wk. Vigorous minutes were multiplied by 2 and added to moderate minutes to get weekly minutes of moderate to vigorous physical activity. Guidelines category assignments are based on participant average weekly reported activity.

[b] Based on sum of 3 skinfolds equation (19).

TABLE 2

Musculoskeletal injury causes: The WIN Study.

	During physical activity	NOT during physical activity	Physical activity not specified[a]	Total
Colliding, tripping, or falling	51	65	1	117
Contact object/personal/animal	17	23	1	41
Motor vehicle	1	13	0	14
Came on gradually and worsened with physical activity	224	41	2	267
Came on suddenly with no apparent cause	25	178	3	206
None of the above	5	10	1	16
Total	323	330	8	661

[a]Participant report and interview were unable to confirm exact nature of the injury.

TABLE 3

Musculoskeletal injury incidence rates[a], The WIN Study.

	No previous MSI reported or observed			Previous MSI reported or observed		
	Below Guidelines[b]	Meets Guidelines	Exceeds Guidelines	Below Guidelines	Meets Guidelines	Exceeds Guidelines
Total weeks enrolled	9027	3754	4517	33,398	18,622	19,832
Number of all MSI reported	26	18	15	259	158	185
Incidence of all MSI	2.88	4.79	3.32	7.75	8.48	9.33
Number of PA-related MSI reported	11	9	8	104	80	111
Incidence of PA-related MSI	1.22	2.40	1.77	3.11	4.30	5.60
Number of non PA-related MSI reported	15	9	7	155	78	74
Incidence of non PA-related MSI	1.66	2.40	1.55	4.64	4.19	3.73

MSI, self-reported musculoskeletal injury; PA, physical activity.

[a]per 1000 person-weeks.

[b]Below Guidelines (31) is <150 moderate to vigorous physical activity min/week; Meets Guidelines = 150–299 moderate to vigorous physical activity min/wk; Exceeds Guidelines is ≥300 moderate to vigorous physical activity min/wk. Vigorous minutes were multiplied by 2 and added to moderate minutes to get weekly minutes of moderate to vigorous physical activity. Guidelines category assignments are based on participant average weekly reported activity from the previous injury week (or baseline if none reported) to the prior week.

TABLE 4

Hazards ratios for musculoskeletal injuries as a function of meeting 2008 USDHHS Physical Activity Guidelines, The WIN Study.

	All MSI		Physical Activity-Related MSI		Non Physical Activity-Related MSI	
Contrast	**HR**	**95%CI**	**HR**	**95%CI**	**HR**	**95%CI**
Meets PAG vs. below PAG[a]	1.16	0.96 to 1.42	1.44[b]	1.08 to 1.91	0.99	0.75 to 1.31
Exceeds PAG vs. below PAG[a]	1.21	0.98 to 1.49	1.66[b]	1.23 to 2.25	0.88	0.65 to 1.21
Exceeds PAG vs. meets PAG	1.04	0.82 to 1.31	1.16	0.85 to 1.58	0.90	0.64 to 1.25
Meets RE PAG vs. not meeting RE PAG[c]	1.04	0.84 to 1.30	1.23	0.92 to 1.66	0.86	0.62 to 1.18

MSI, self-reported musculoskeletal injury; HR, hazard ratio; CI, confidence interval; PAG, 2008 USDHHS Physical Activity Guidelines (31); RE = resistance exercise.

[a]Below Guidelines is <150 moderate to vigorous physical activity min/week; Meets Guidelines = 150–299 moderate to vigorous physical activity min/wk; Exceeds Guidelines is ≥300 moderate to vigorous physical activity min/wk. Vigorous minutes were multiplied by 2 and added to moderate minutes to get weekly minutes of moderate to vigorous physical activity. Guidelines category assignments are based on participant average weekly reported activity from the previous injury week (or baseline if none reported) to the prior week.

[b]$P < .05$

[c]Meets RE Guidelines of ≥2 days/week.

TABLE 5

Hazards ratios for physical activity-related musculoskeletal injuries as a function of previous injury and BMI category, The WIN Study.

Contrast	Incidence per 1000 weeks (N of PA-related MSI)	HR	95%CI
No previous MSI			
Normal weight BMI (referent)[a]	0.954 (6)	--	--
Underweight BMI vs. Normal weight BMI	NA[b]	NA[b]	NA[b]
Overweight/obese BMI vs. normal weight BMI	2.00 (22)	2.15	0.91 to 5.09
Previous MSI			
Normal weight BMI (referent)	5.11 (134)	--	--
Underweight BMI vs. Normal weight BMI	3.25 (5)	0.76	0.33 to 1.73
Overweight/obese BMI vs. normal weight BMI	3.52 (155)	0.76[c]	0.59 to 1.00

BMI, body mass index; HR, hazard ratio; CI, confidence interval; MSI, Musculoskeletal injury.

[a]Referent group in each contrast is normal weight BMI (18.5 to <25 kg/m^2).

[b]NA due to no cases in this strata

[c]$P < .05$