Does moderate to vigorous physical activity reduce falls?

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Background

• Research on fall prevention has emphasized: (1) multifactorial fall prevention programs and (2) fall prevention exercise programs.

• In April 24, 2018 issue of JAMA, USPSTF recommendations for fall prevention:
  – “B” for exercise
  – “C” for “selectively offer multifactorial interventions”
  – “D” for vitamin D (= against)

Example of fall prevention exercise: Otago exercise program

• Home-based; 30 min sessions; 3 times/week
  – Warm-up (flexibility)
  – 5 leg muscle strengthening exercises w/ 4 levels difficulty
  – 12 dynamic balance “retraining” exercise w/ 4 levels difficulty.

• What about walking/MVPA?

  “Participants should aim for up to 30 minutes, walking at their usual pace, at least twice a week, if safe.”

Otago manual available at: www.acc.co.nz/otagoexerciseprogramme
Controversy re: how MVPA (including walking) may influence risk of falls

- Meta-analysis: fall prevention exercise programs more effective if do not include walking [1] (note: there are no dose-response RCTs)

- RCT: the effect of walking exercise on fall risk was non-significant (IRR = 0.88, 95% CI: 0.60–1.29) [2]

- Cohort study: Moderate to high levels of accelerometer-measured MVPA reduces risk of incident sarcopenia (OR=0.64. 95% CI 0.45-0.91) [3]

- Cohort study: inverse dose-response relationship exists: **higher** levels of self-reported MVPA associated with **lower** fall risk and lower fracture risk (concluding “at least daily MVPA is required for primary prevention of falls....”) [4]

- Cohort study: Effects of MVPA depend upon physical function: In **men** with mobility limitations, higher accelerometer-measured MVPA associated with lower risk [5]

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Study Questions

• In a prospective cohort study of older women where MVPA is measured by accelerometer:

  – 1) Is MPVA associated with incidence of falling in older women?

  – 2) Do associations of MVPA with fall incidence vary by physical function and past history of falls?

  – 3) Does MVPA affect whether falls are injurious or require medical care?
Study Sample

- Women participants (aged 63-99) in OPACH
  
  - Consented:  N= 8618
  - Excluded:  N= 2048
  - Received accelerometer:  N= 6570
  - Sufficient accelerometer data:  N= 5798
  - Participate in ≥ 1 month of falls monitoring:  N=5545 (final sample)

(exclusion criteria = death, unable to walk, institutional residence, unable to follow instructions/fill out questionnaires, unable to contact, refusal, no home visit, SPPB=0)
Exposure = Minutes/day of (Accelerometer-measured) MVPA

- ActiGraph GT3X+ worn at hip 24/7 for 1 week
  - Calculate VM (vector magnitude) counts for each/15 second epoch
  - MVPA: >519 VM counts/15 s
  - Remove time in bed using sleep logs
  - Non-wear = 90+ minutes of 0 counts
  - Sufficient accelerometer data: 10+ hours of wear on 4+ days (% with insufficient data=12%)
1<sup>st</sup> Outcome = Rate of incident falls

- 13 months of prospective falls monitoring (baseline = month accelerometer was worn)
  - Monthly calendars provide definition of a fall
  - For each day, participants checked “fall” or “no fall.”

- Fall rate = #falls/# person-months of follow-up

- A stratified sample of participants interviewed by phone re: fall injuries
Covariates & Subgroup Variables

- Covariates in multivariate analysis:
  - Age, race/ethnicity, education, accelerometer wear time
  - Questionnaire measures of: vision, body pain, alcohol use, sleep aid use, chronic condition score. Measured: body mass index

- Measure of physical function:
  - SPPB (Short Physical Performance Battery) scored 1-12 (higher scores = better function)

- History of falls in past year (self-report): 0, 1, or 2+
Statistical Analysis

• (1) **Negative binomial regression** used to test association of MVPA quartiles with fall rates, with adjustment for covariates
  – Appropriate for highly skewed fall rate data
  – Assumes linear relationships

• (2) **Non-parametric negative binomial generalized additive models** used to plot fall rates by MVPA as continuous variable
  – Allows flexible modeling of non-linear relationships
  – Models done separately for: 0/1 falls, 2+ falls, SPPB 1-8, SPPB 9-12
Characteristics of Study Sample

- Mean age = 79 yrs

- # falls in past year:
  - 0 = 69%
  - 1 = 20%
  - 2+ = 11%

- SPPB score:
  - 1-4 = 8% ***
  - 5-8 = 42%
  - 9-12 = 50%

- Selected fall risk factors
  - Use sleep aid ≥1-2 days/wk: 17%
  - Alcohol 1+ drink/wk: 29%
  - Good/Fair/Poor vision: 48%

*** For thoughtful discussion of how this feature influences study interpretation, see editorial: Judge J. Can physical activity prevent falls in older adults with poor physical performance? *J Am Geriatric Soc* 2017; 65:2457-8
Question #1: Is MVPA Associated with incidence of falling?

Full sample in the analysis

<table>
<thead>
<tr>
<th>Quartile of MVPA (minutes/day)</th>
<th>IRR (95% CI)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Q1   &lt;25.1</td>
<td>1.18 (1.01 – 1.38)</td>
</tr>
<tr>
<td>Q2  25.1 - &lt;44.1</td>
<td>1.01 (0.87 – 1.16)</td>
</tr>
<tr>
<td>Q3  44.1 - &lt;69.3</td>
<td>0.98 (0.86 – 1.13)</td>
</tr>
<tr>
<td>Q4   &gt; 69.3</td>
<td>ref</td>
</tr>
<tr>
<td>P value for trend</td>
<td>.04</td>
</tr>
</tbody>
</table>

Non-significant (p for trend 0.38) association: quartile of light PA and fall incidence

Adjusted for age, race/ethnicity, education, wear time, vision, body pain, alcohol use, sleep aid use, body mass index, chronic conditions
Question #2:
Do associations of MVPA with fall incidence vary by level of physical function and past history of falls?

Interaction $p = .03$

Note: 90%tile of MVPA = 98 min/d
Question #2:
Do associations of MVPA with fall incidence vary by level of physical function and past history of falls?

**Interaction p < .001**

Adjusted for age, race/ethnicity, wear time, body pain, alcohol use, sleep aid use, body mass index, 10 item chronic condition score
Question #3
Does MVPA affect whether falls are injurious or require medical care?

• 2495 interviews with women who reported falls; 763 (30.6%) reported some type of injury

• Percent of fall interviews reporting an injury requiring medical treatment
  – Higher MVPA (Q3+Q4): 9.9%
  – Lower MVPA (Q1+Q2): 13.0% (p<.001)

• Percent of fall interviews reporting fracture injury
  – Higher MVPA (Q3+Q4): 3.7%
  – Lower MVPA (Q1+Q2): 4.9%
Study Strengths & Limitations

• Device-measured MVPA
  – 88% had sufficient accelerometer data
  – 84% had both accelerometer data and fall data. (~75% of these women returned 12+ fall calendars)

• Large diverse study sample

• Prospective ascertainment of falls / adjustment for fall risk factors

• Unclear whether low MVPA increases risk of falls vs. identifies a group of women with conditions that prohibit MVPA.
  – Women may self-select a level of MVPA they perceive as safe; in some women, going from low to medium MVPA possibly increases fall risk.

• High levels of MVPA infrequent, so lower statistical power in studying risk of falls at high levels of MVPA
Conclusions

• Q1: In older women, low levels of MVPA were associated with increased fall rates. Women with moderate to high MVPA had similar & lower fall rates.

• Q2: The association of MVPA with fall rates differed significantly by SPPB score and past history of falls.
  – In women at higher fall risk (SPPB 1-8, 2+ falls in past year), low levels of MVPA were associated with higher fall risk.
  – At lower fall risk, no association.

• Q3: Women who fell and had low levels of MVPA were more likely to have medically-treated falls.
Overall Conclusions

• Falls were not more common or more injurious in women who engaged in moderate to high levels of MVPA, regardless of physical function or history of falls.

• These findings support conducting RCT’s of benefits and risks of increasing MVPA in women:
  – 1) at increased fall risk
  – 2) do low amounts of MVPA
Next Steps

- Approved manuscript proposals to analyze raw accelerometer data;
  - Extract walking bouts using an algorithm
  - Use machine learning to derive features of walking and determine ability of features to classify fall risk/functional status

Data (30 Hz) from each axis of a hip accelerometer during walking

(from 400 m walk data of OPACH calibration substudy; anterior-posterior (blue), vertical (green), and mediolateral (red))
Link of Otago Exercise Program Research to Light Activity Research?

- Meta-analysis: Otago exercise does not just reduce fall risk, but also mortality risk (RR = 0.45, 95% CI=0.25-0.80; f/u= 12 months)
  - Average age 81.6%; RCT participants mainly women

Heterogeneity I² = 0%

Thomas et al. *Age Ageing* 2010;39:681-687
OPACH Team (some of us)