Penn Medicine

Gamification, Financial Incentives, or Both to Increase Physical Activity Among Patients at High Risk of Cardiovascular Events:
The BE ACTIVE Randomized Controlled Trial

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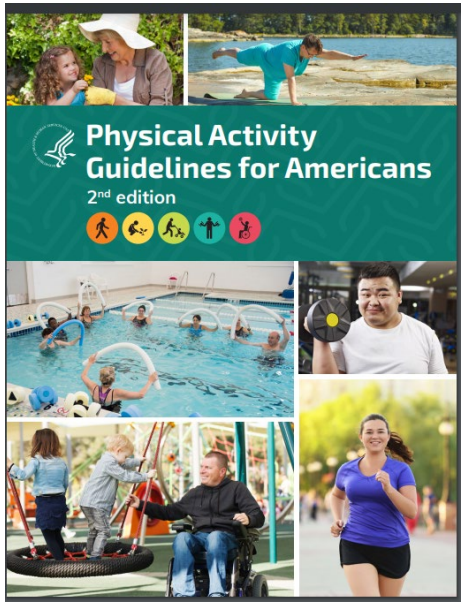
Physical activity



- Many benefits
  - ↓ all cause and CV mortality
  - ↓ risk of heart disease and stroke
  - ↓ risk of hypertension, diabetes, hyperlipidemia
- CDC recommends 150 minutes/week of moderate to vigorous physical activity, but few exercise that much – especially older adults at highest risk for CVD
- In short-term studies:
  - Gamification increases physical activity
  - Financial incentives increase physical activity
- But it is not certain how long these effects last, or which approach is better

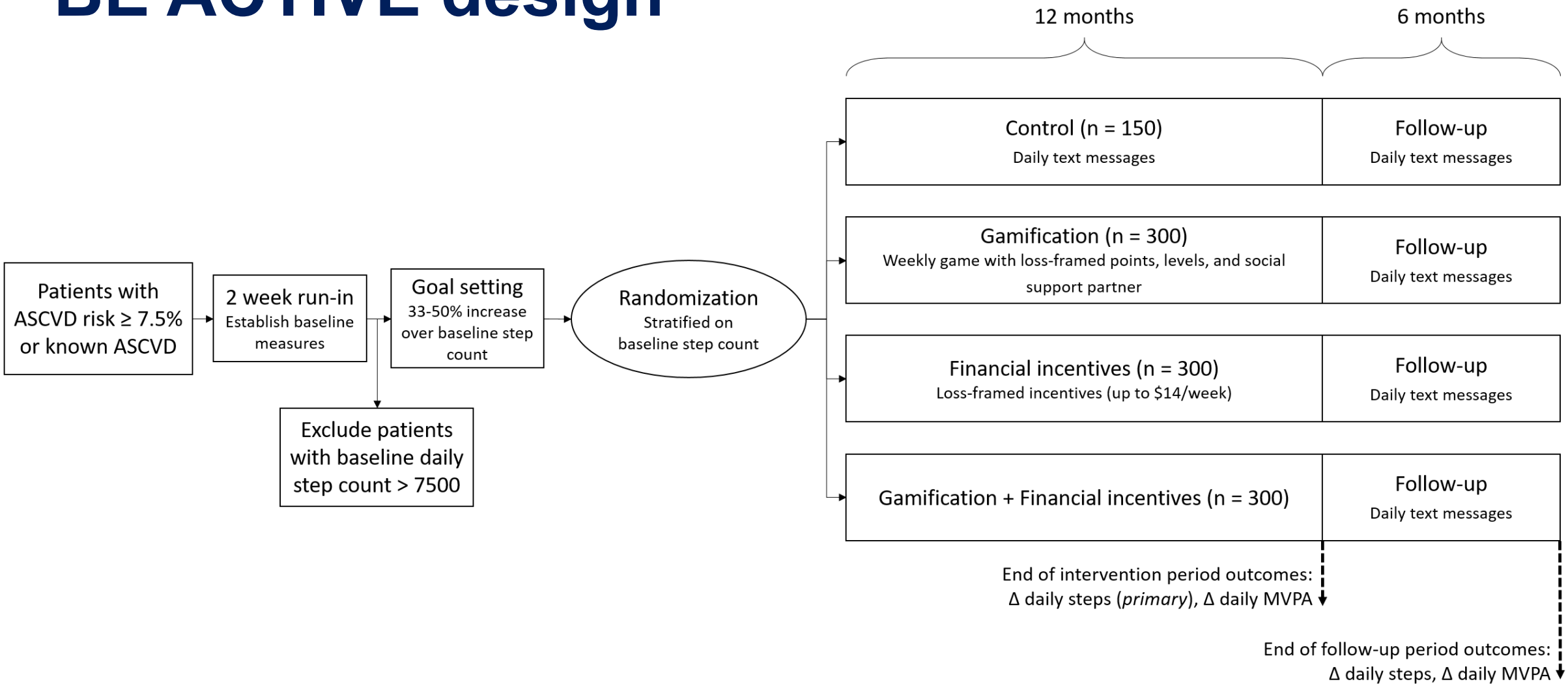
Objectives

- To determine the effectiveness of behaviorally-designed gamification, loss-framed financial incentives, or the combination versus control for increasing physical activity over a 12-month intervention and 6-month follow-up period

Design: Patient population

- Age > 18
- 10-year ASCVD event risk > 7.5% or established vascular disease
- Have a Penn Medicine PCP
- Able to provide informed consent
- Own device (smartphone or tablet) able to transmit data from the wearable
- Not participating in another physical activity study
- No reason an 18-month physical activity program is unsafe or infeasible
- Baseline step count < 7500

BE ACTIVE design



Way To Health

Evidence Based Patient Engagement

- Automated patient communication
- Device integration
- Clinical Trials
- Behavioral Economics
- Gamification
- Customizable Rules Engine

Design: gamification

- Each week, participants are endowed with 70 points
- Each day a participant does not meet his/her step goal, he/she loses 10 points
- At the end of each week, points will determine whether participants move up or down a level based on weekly point total (> or < 40)
- Daily text messages note the number of points the participant has
- Participants start in the middle level
- After 8 weeks, participants in lower levels restarted back at middle and offered a chance to reset goals
- Weekly emails to support partner

Design: financial incentives

- Each week, $14 is put in each participant's virtual account
- Every day they don't meet their step goal, they lose $2; if they meet their goal, they keep their money

Power calculations

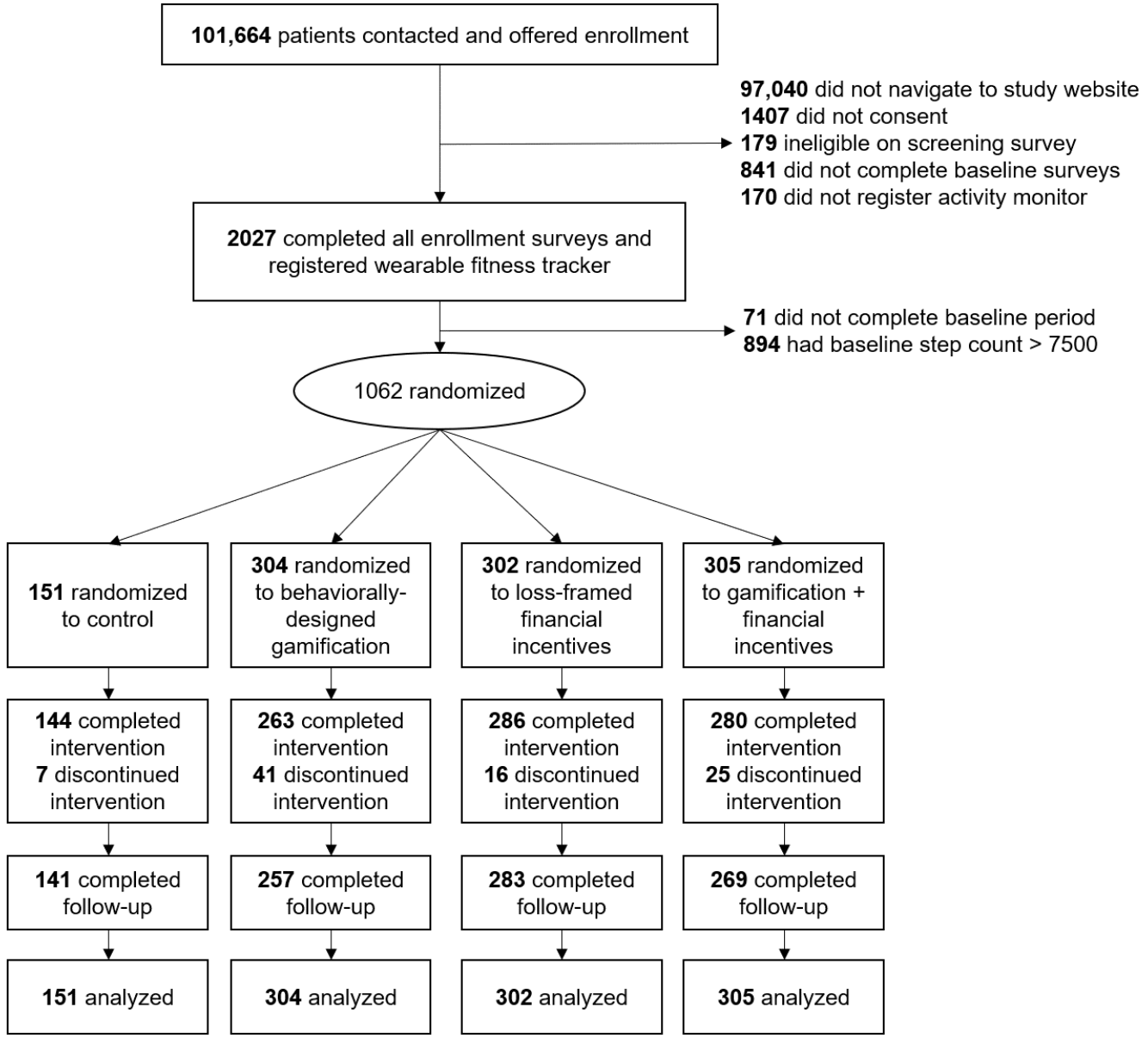
- Powered for 6 comparisons between arms keeping the familywise error rate < 0.05
  1. Three intervention arms vs. control – Bonferroni adjustment of type 1 error rate with two-sided α = 0.017
  2. Only intervention arms significant versus control were compared with each other, with same adjustment of type 1 error rate
- With 300 patients in the intervention arm and 150 patients in the control arm, we estimated 93% power to detect a difference of 1000 steps and 85% power to detect a difference of 750 steps, assuming a 10% drop-out rate

Methods

- All randomly assigned patients were included in the intention-to-treat analysis
- Multiple imputation for days with missing step count or values < 1000
  - Sensitivity analyses using only captured data without imputation
- Generalized linear mixed effect regression models to evaluate changes from baseline in daily steps and minutes of MVPA
- Powered to compare all 3 interventions vs. control using Bonferroni adjustment of type 1 error rate with two-sided α = 0.017
  - Intervention arms significant versus control were compared with each other, with same adjustment of type 1 error rate
  - 93% power to detect a difference of 1000 steps and 85% power to detect a difference of 750 steps

Participant flow

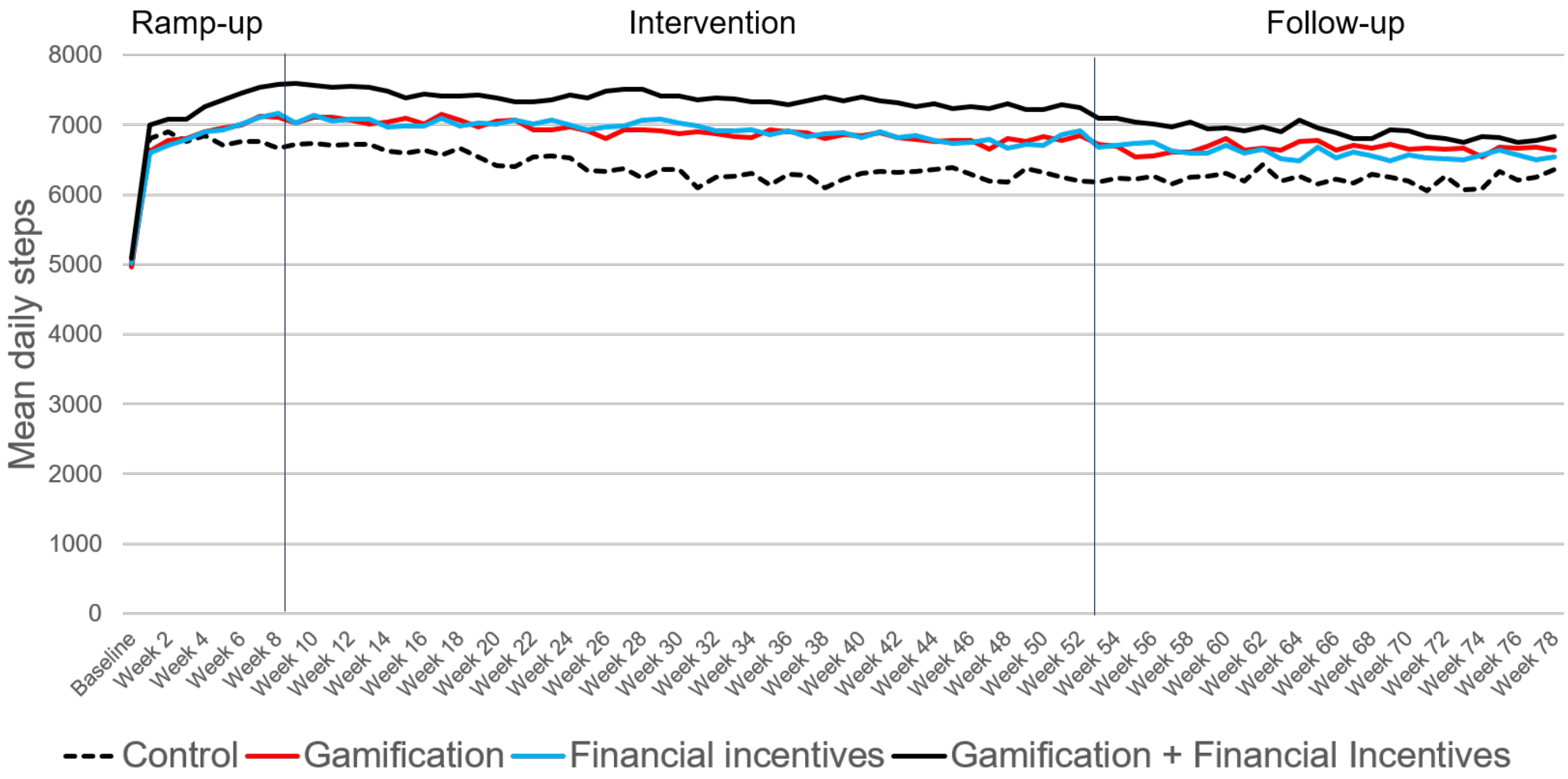
- 91.6% (n = 973) completed the 12-month intervention
- 89.4% (n = 950) completed the 18-month study



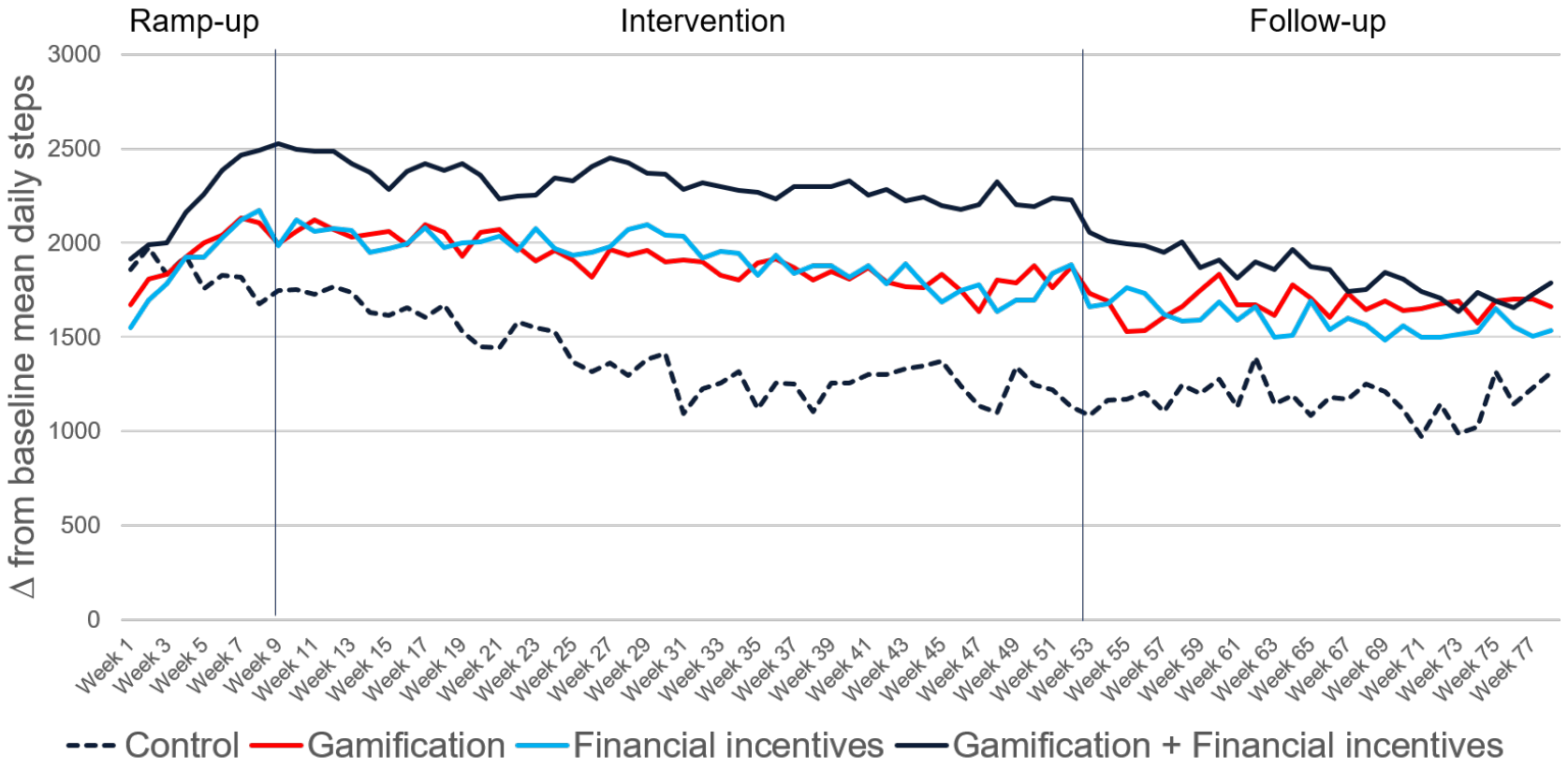
Baseline characteristics

	Control	Gamification	Incentives	Combination
Age	66.6	67.2	66.4	66.6
Black	27%	25%	27%	22.3%
Annual household income < $50k	32%	20%	24%	20%
Diabetes	25%	21%	22%	25%
Hyperlipidemia	51%	54%	56%	51%
Hypertension	62%	62%	64%	60%
Smoking	7%	3%	4%	4%
Baseline step count	4980	4958	5018	5081
Step goal increase	1855	1890	1890	1826

Change in daily steps



Change from baseline daily steps



Main intervention period

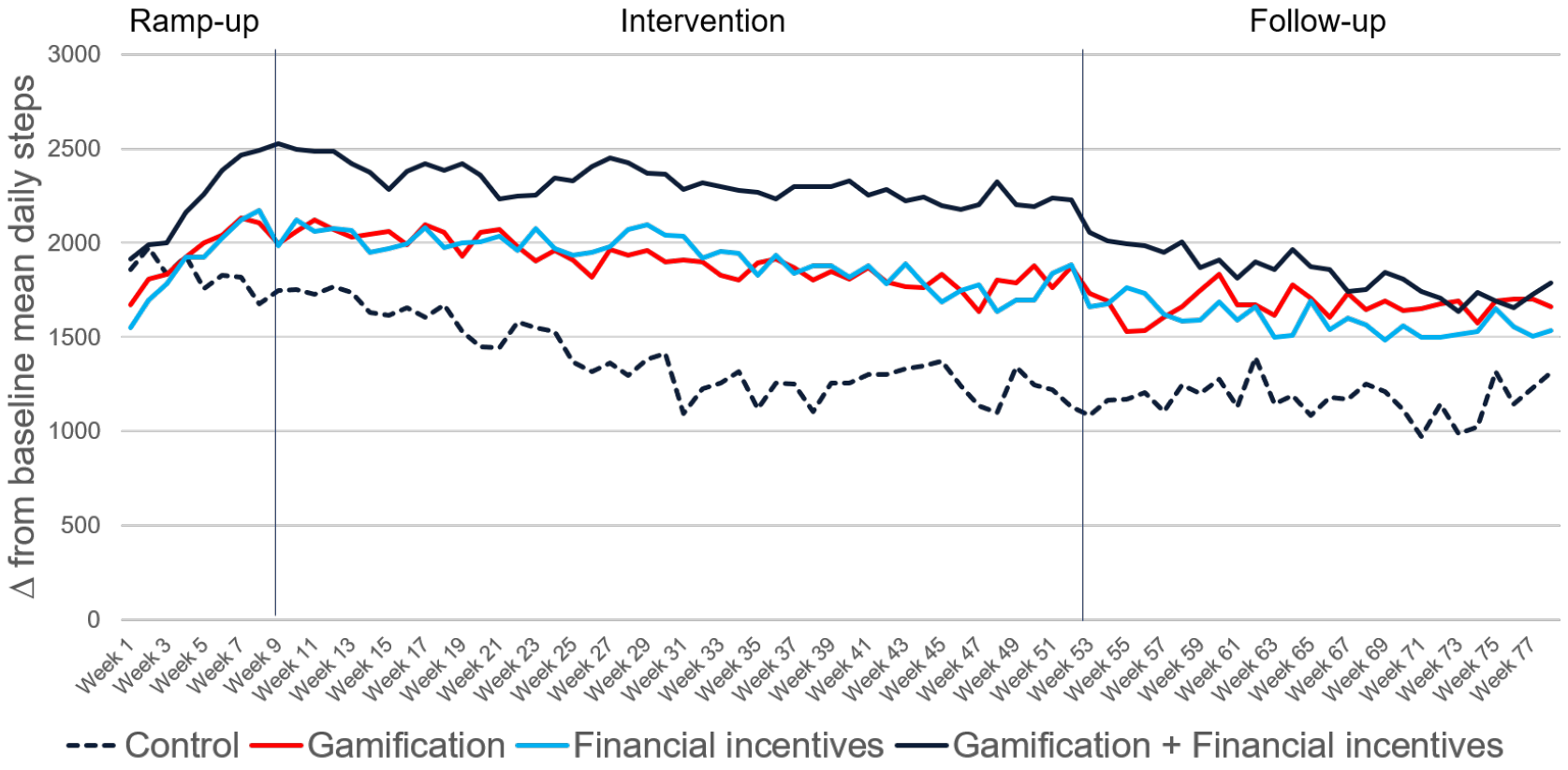
Control: +1418
from baseline

Gamification +1954
from baseline (+538 over control)

$ Incentives: +1915
from baseline (+492 over control)

Combination: +2297
from baseline (+868 over control)

Change from baseline daily steps



Follow-up period

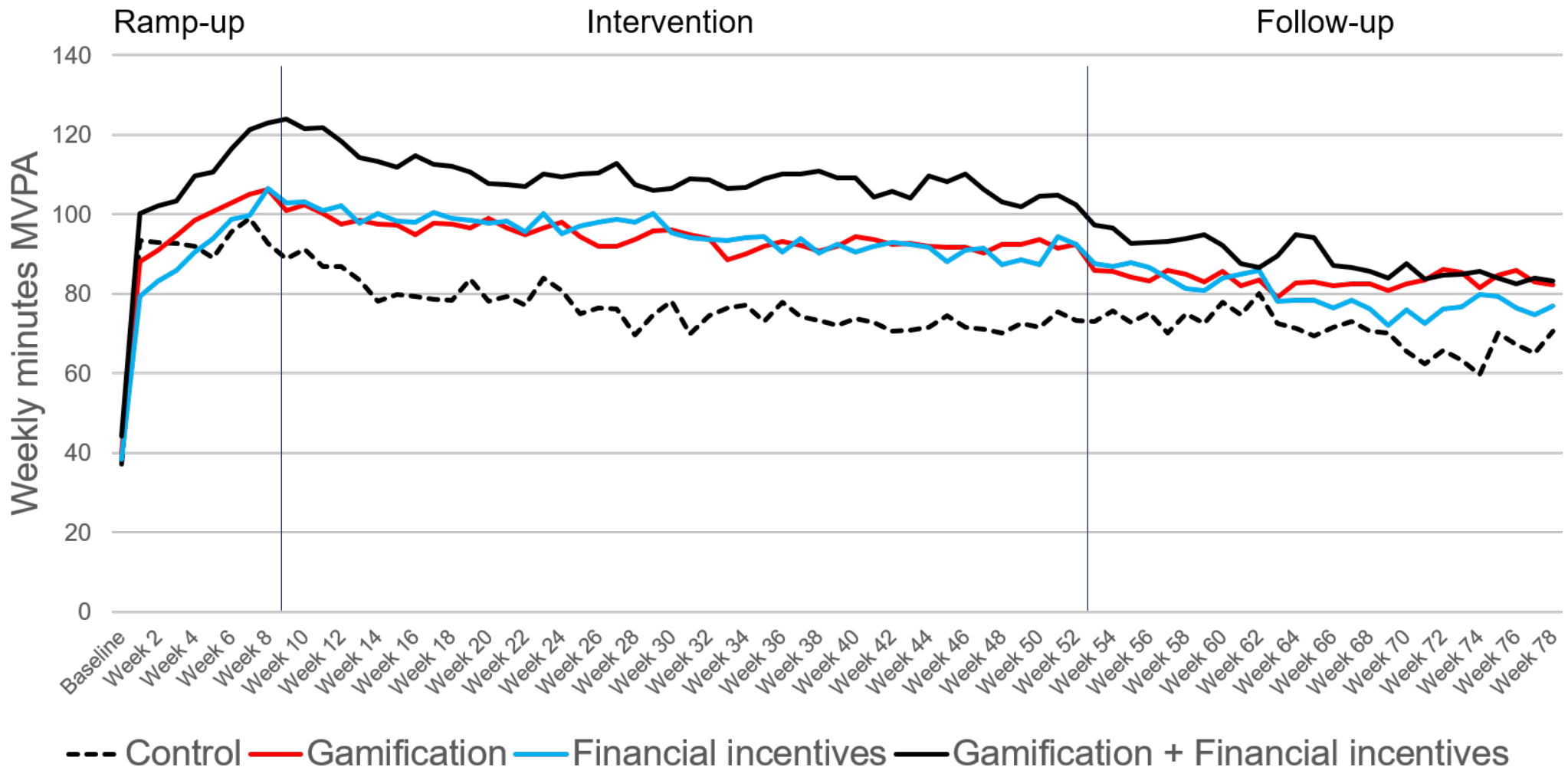
Control: +1245
from baseline

Gamification +1708
from baseline (+460 over control)

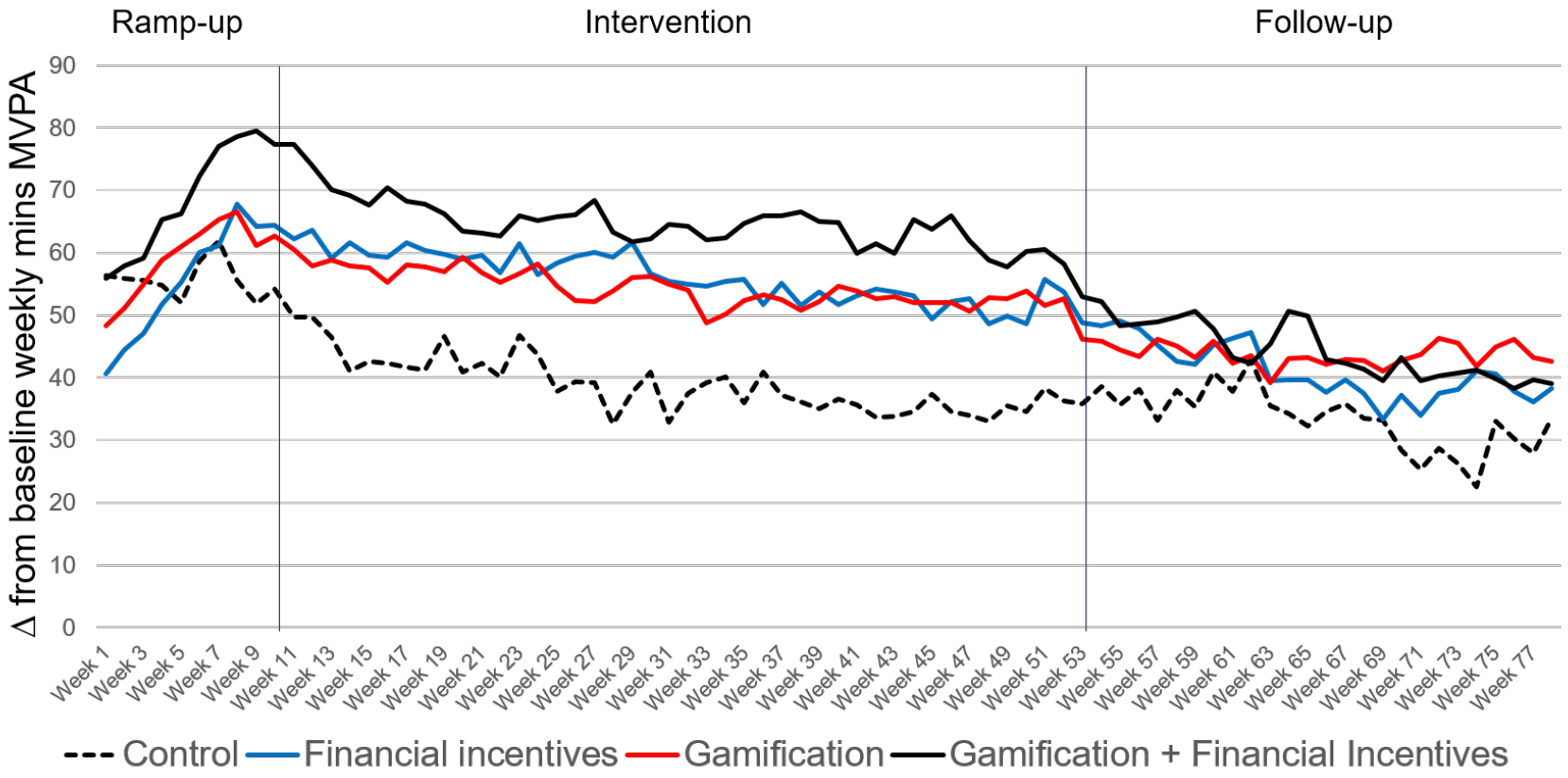
$ Incentives: +1576
from baseline (+328 over control)

Combination: +1831
from baseline (+576 over control)

Change in weekly MVPA



Change from baseline weekly minutes MVPA



Main intervention period

Control: +40

from baseline

Gamification +55

from baseline (+15 over control)

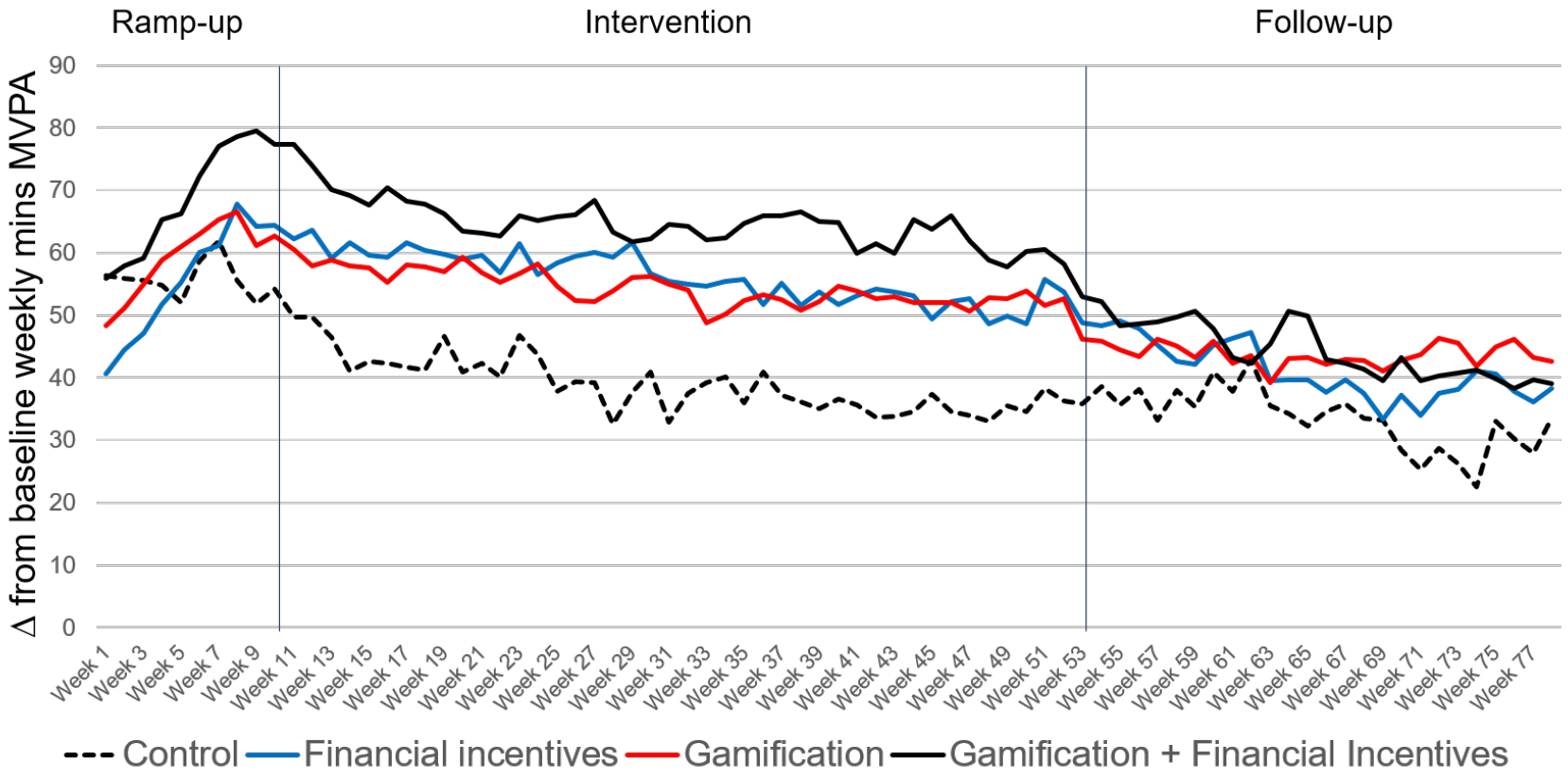
$ Incentives: +57

from baseline (+17 over control)

Combination: +65

from baseline (+26 over control)

Change from baseline weekly minutes MVPA



Follow-up period

Control: +37
from baseline

Gamification +51
from baseline (+11 over control)

$ Incentives: +51
from baseline (+8 over control)

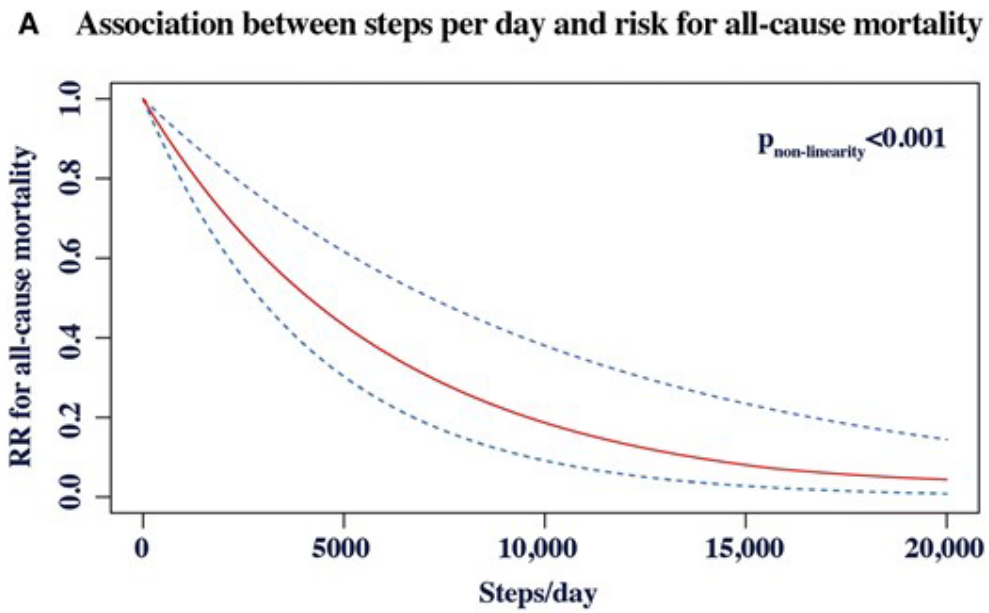
Combination: +58
from baseline (+13 over control)

Limitations

- Participants volunteered to participate
  - Many more invited than ultimately participated and results may not be fully generalizable
- Used commercial devices rather than research grade accelerometers
  - Pragmatic, doesn’t add bias, but may be less accurate
- Did not measure the effect of the intervention on clinical outcomes
  - Dedicated clinical trials needed

Implications

- In observational studies, there is an inverse association between steps per day and outcomes (mortality, CV events)
  - From baseline 5000 steps per day
    - 1700-step increase → ~1.2 years longer life expectancy
    - 500-step increase → ~ 0.4 years longer life expectancy
- ***These highly scalable, automatically delivered interventions increase physical activity over long-term periods in patients at high risk for CV events and could improve outcomes***



Thank you!

Patients and families

Study team

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