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Original research

In search of lost time: When people undertake a new exercise program, where does the time come from? A randomized controlled trial

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ABSTRACT

Objectives: The objective of this study was to investigate changes in use of time when undertaking a structured exercise program.
Design: This study used a randomized, multi-arm, controlled trial design.
Methods: A total of 129 insufficiently active adults aged 18–60 years were recruited and randomly allocated to one of three groups, a *Moderate* or *Extensive* six-week exercise group (150 and 300 additional minutes of exercise per week, respectively) or a *Control* group. Prescribed exercise was accumulated through both group and individual sessions. Use of time was measured at baseline and end-program using the Multimedia Activity Recall for Children and Adults, a computerized 24-h recall instrument. Daily minutes of activity in activity domains and energy expenditure zones were determined.
Results: Relative to changes in the control group, daily time spent in the physical activity [$F(2, 108) = 20.21$, $p < 0.001$] and Active Transport [$F(2, 108) = 3.71$, $p = 0.03$] time use domains significantly increased in the intervention groups by 21–45 min/day. Comparatively, the intervention groups spent significantly less time watching television [$F(2, 108) = 5.02$, $p = 0.008$; −50–52 min/day], relative to Controls. Additionally, time spent in the moderate to vigorous energy expenditure zone had significantly increased in the intervention groups by end-program [$F(2, 108) = 6.35$, $p = 0.002$; 48–50 min/day], relative to Controls.
Conclusions: This study is the first to comprehensively map changes in time use across an exercise program. The results suggest that exercise interventions should be mindful not only of compliance but also of "isotemporal displacement" of behaviors.

1. Introduction

When people undertake a new exercise program, the time spent in other domains, such as sleep or screen time, must be reduced to accommodate the new activity. If someone starts jogging at lunchtime, for example, they will need to find time not only for the jogging, but also for changing into exercise clothes, showering and changing back into work clothes after the run. Where does this time come from? Which "time reservoirs" are drawn upon?

Decisions about how to restructure time budgets to accommodate new physical activity (PA) can have important health consequences. If a new exerciser chooses to reduce their screen time, for example, then there will presumably be additional health benefits, given that sedentary time is a risk factor for all-cause mortality and cardiovascular disease independently of physical activity.[1,2] Conversely, if they choose to sleep less, the benefits of physical activity may be reduced. Shorter sleep duration has been associated with greater risk of obesity[3] and depression,[4] though both of these health issues may also be mitigated by physical activity.[5,6] A further possibility is that a new exerciser will reduce physical activity in other domains, so that there will be no net increase in physical activity. This is the so-called "activitystat" hypothesis.[7]

Clearly, in order to accurately assess the overall effects of physical activity interventions we should investigate both changes in physical activity and the isotemporal displacement of other activities which potentially impact on health outcomes. Similarly, in order to distinguish true dose–response relationships, ripple effects, that is, the flow on effects from changes in time use, must be

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measured and considered. To date, physical activity interventions (and other time-based behavior change interventions) have generally employed either simple physical activity questionnaires,[8] or wearable, objective 24 h monitoring devices,[9] to assess the effects of their interventions. These methods lack the ability to capture the domain- and attribute-specific benefits of physical activity[10] and its flow-on effects. Alternatively, a time substitution approach allows detailed examination of these flow-on effects and allows identification of which activities are reduced or altered to accommodate the increased time for exercise. The time substitution approach is therefore one method by which the true relative effects of changes in behavior, such as increased physical activity, or reduced TV watching on energy intake and expenditure, can be examined.[11]

This study aimed to investigate how previously inactive adults modify their time budgets when they undertake a new physical activity program. The research question was: How does the adoption of a six-week physical activity program change average daily minutes spent in mutually exclusive time use domains and energy expenditure zones? This study was conducted within a larger randomized controlled trial aimed at investigating the existence of an activitystat.[12]

2. Methods

Ethics approval for this study was gained from the University of South Australia Human Research Ethics Committee. This study used a randomized controlled, multi-arm, parallel trial design, with two intervention groups and one control group and was registered with the Australian and New Zealand Clinical Trials Registry (ACTRN12610000248066).

Participants were recruited via email and print advertising from a metropolitan university, a tertiary hospital and several government departments. Interested participants were invited to attend a laboratory session to complete informed consent and the Active Australia Survey.[13] Participants were required to be insufficiently active, defined as accumulating less than 150 min of moderate to vigorous PA per week on average according to the Active Australia Survey, where total weekly physical activity time is calculated by adding the time reported in walking and moderate activity plus twice the reported vigorous activity time.[13] Participants were required to be aged 18–60 years and cleared for exercise under the Sports Medicine Australia pre-exercise screening criteria.[14] A broad age range was applied to this study to maximize generalizability of results.

Following baseline testing, participants were randomized into one of three groups using a computer-generated random allocation sequence by a person external to the study, with allocation concealment maintained until moment of allocation. Participants allocated to the control group were wait-listed for the exercise component of the program once their formal testing was completed and in the meantime were given no specific instructions other than to continue with their usual routines. Participants in the two intervention groups took part in a six-week physical activity program based on a previously designed and tested physical activity intervention.[15] For further information regarding the development of this intervention please see Norton et al.[15] This physical activity intervention was chosen because it was a high volume program that had previously demonstrated high compliance and would therefore provide a sufficient stimulus for changes in time use.

Briefly, those randomized to the Moderate intervention group were asked to increase their physical activity by 150 min/week, half of which was to be accumulated in structured, supervised group classes, and half in their own time using modalities of their choice. Those randomized to the Extensive intervention group were asked to increase their physical activity by 300 min/week, half of which was again to be accumulated in supervised classes, and half in their own time. The supervised sessions were run separately for the two intervention groups and were conducted by an exercise physiologist. These group sessions consisted of a wide variety of group activities such as circuit classes, sports, boxing, dancing, bushwalking and kayaking. For the full protocol including physical activity prescription and activities of both groups, please see Gomersall et al.[12] Uncompensated, these sessions would be expected to increase overall daily energy expenditure by approximately 5% (Moderate) and 10% (Extensive).

Control and intervention participants undertook a battery of tests at five time periods during the study: baseline (the week before the program began), mid-program (weeks 3–4), end-program (week 6), and at 3- and 6-month follow-up (weeks 12 and 24 following the intervention). This paper will present the baseline and end-program results with regards to use of time recalls.

Use of time was measured using the Multimedia Activity Recall for Children and Adults (MARCA), a computerized 24-h use of time recall tool.[16] The MARCA asks participants to recall everything they did in the previous 24 h from midnight to midnight, using meals as anchor points. Participants choose from over 500 discrete activities (for example “sitting-eating”, “brushing teeth” or “watching television – lying down”), with the minimum time for an individual activity being five minutes. The MARCA has been modified and validated for adults.[16] Each activity in the MARCA is assigned a MET value based on an expanded version of the Compendium of Physical Activities,[17,18] so that energy expenditure can be estimated. The adult version of the MARCA has test–retest reliabilities in adults of 0.920–0.997[16] for major activity sets such as sleep, physical activity and screen time, and convergent validity between physical activity level (PAL, estimated average rate of energy expenditure) and accelerometer counts/minute of rho = 0.72.[16] A recent comparison with the gold standard doubly-labeled water[19] showed correlations of rho = 0.70 for total daily energy expenditure.

At baseline and end-program, the MARCA was administered by telephone to both intervention and control participants by trained interviewers who were blinded to the group allocation of the participant. Each time, two separate calls were made one week apart, during which participants recalled the two previous days. At each time point participants therefore recalled four days of activity, including at least one weekday and one weekend day. For each individual participant, wherever possible, the same days of the week were recalled at each time-point.

Daily minutes of activity were calculated by summing the number of minutes participants reported being involved in each activity, and averaging them across the four recall days using a 5:2 weighting for weekdays:weekend days to capture typical weekly patterns. The 520 activities in the MARCA were combined into “activity sets” and collapsed hierarchically into domains based on similarity and to preserve comparability with previous work with adolescents.[20,21] This process was completed by three researchers (including SG and TO) first independently, followed by discussion to settle any differences or disagreements. Eleven mutually exclusive and exhaustive activity “superdomains” were identified: Physical Activity, Computer, Active Transport, Passive Transport, Quiet Time, Self-Care, Socio-Cultural, Work/Study, Chores, Sleep, and TV/Videogames. Descriptions for each superdomain are included in the supplementary material. Activities were also clustered into three energy expenditure zones: 1–1.9 METs (sedentary); 2–2.9 METs (light PA); ≥3 METs (moderate to vigorous PA). Physical activity level (PAL, in METs) was calculated using the factorial method, that is by multiplying the rate of energy expenditure associated with each activity (in METs), by the number of minutes for which that activity was performed, summing them across the day, and dividing by 1440 (minutes per day).

Because this study addresses how use of time changes when individuals participate in an exercise program, analyses were