## RESEARCH LETTER

# Short-term Healthy Lifestyle Intervention and Long-term Behavior Change After Kidney Transplantation: Findings From the CAVIAR Study

*To the Editor:*

Our previous work explored the benefit of active versus passive lifestyle modification in nondiabetic kidney transplant recipients in the CAVIAR randomized controlled trial.[1] It introduced the concept of incorporating evidence-based behavior change therapy (BCT) into posttransplant care. While failing to show any benefit in the primary outcome of glycemic pathophysiology, it demonstrated improvements in secondary outcomes including weight and fat mass, and a trend toward less posttransplantation diabetes mellitus (PTDM; 7.6% vs 15.6%) for active versus passive intervention arms, respectively, after a 6-month personalized intervention.

However, evidence for long-term adherence to health behavior change is poor in the general population.[2] Typically, encouraging early response after any targeted behavior change intervention is followed by diminished adherence in the long term. Low self-reported health,[3] depression,[4] and lack of motivation[5] are linked to poor adherence to lifestyle changes in the general population, but evidence for this posttransplant is lacking.

One of the a priori CAVIAR study objectives was to explore if behavior change is sustained after study completion. Details of the CAVIAR study and 6-month outcomes have been reported.[1] For this analysis, changes in 3-year outcomes from baseline were compared between randomized cohorts. Poststudy outcomes were linked to psychological measures tested during the original CAVIAR trial to determine associations. This included EQ-5D (questionnaire relating to health status and quality of life),[2] the Beck Depression Inventory (specific tool for depression),[3] and the Situational Motivation Scale (specific tool to assess motivation).[4] Detailed methods are given in Item S1.

Fig S1 provides a flow diagram for data analysis. As shown in Fig 1, active versus passive study participants experienced divergent weight during study participation but converge back to baseline weight after study completion. Fig S2 provides a scatterplot of weight change during versus post study period, stratified by randomization status for individual participants. Table 1 highlights similar cardiometabolic and safety parameters between study participants at 3 years, including no significant difference in PTDM (16.1% vs 13.6% for active versus passive intervention arms, respectively, P = 0.7). No association was observed between participant age, body mass index, ethnicity, or sex with evolution of weight either during or after study completion (Figs S3 and S4).

Multiple linear regression analysis is reported in Table S1. With regard to weight change during study intervention, the overall regression model was not significant but the randomization group significantly predicted weight change (coefficient estimate, 2.14 [95% CI, 0.56-3.73]; P = 0.009). For weight change after study

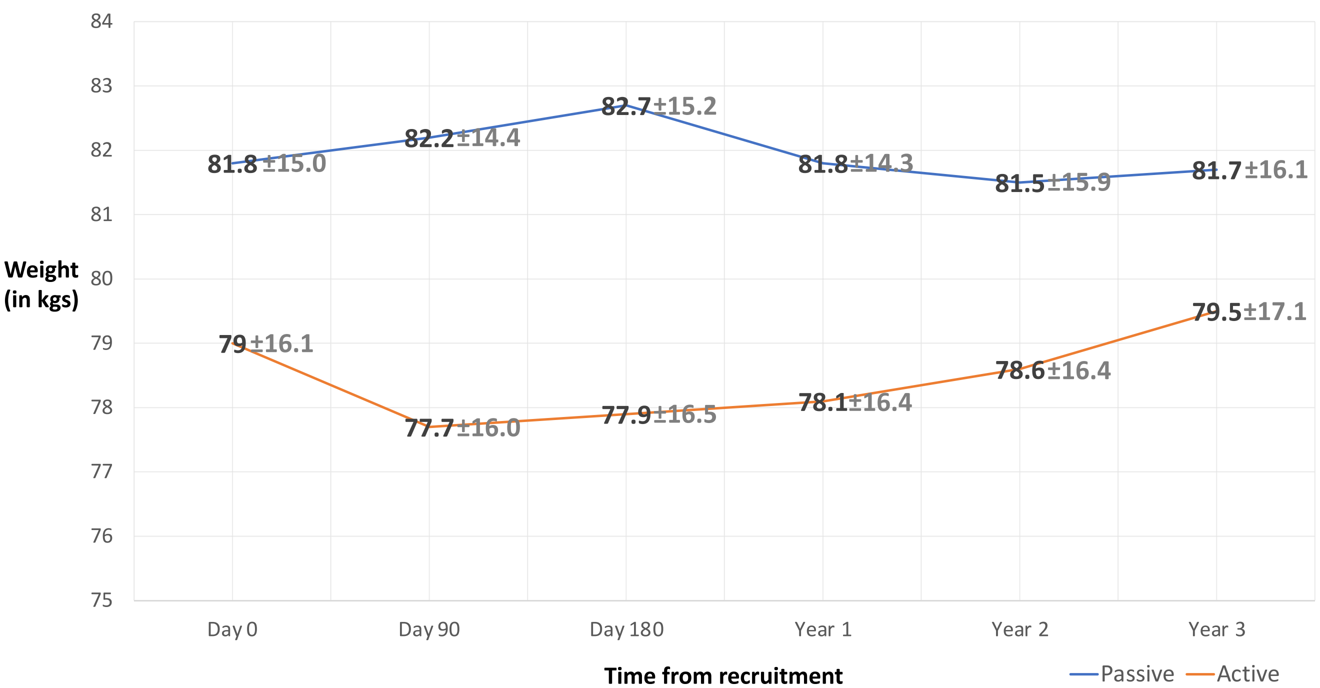


**Figure 1.** Evolution in weight (± SD) during the CAVIAR study (days 0-180 from recruitment) and after study completed (day 180 to year 3).

**Table 1.** Comparison of Cardiometabolic Parameters in Active Versus Passive Lifestyle Intervention Groups

| Variable | Active Group[a] (n = 66) | Passive Group[a] (n = 64) | P |
|---|---|---|---|
| Δ Weight, kg | +0.5 | −0.1 | 0.7 |
| Δ Systolic BP, mm Hg | +9.2 | +12.7 | 0.4 |
| Δ Diastolic BP, mm Hg | +0.23 | +0.60 | 0.9 |
| Antihypertensive drugs | 74.2% | 79.7% | 0.5 |
| Δ Total cholesterol, mmol/L | +0.44 | +0.31 | 0.6 |
| Lipid-lowering drugs | 58% | 42% | 0.4 |
| PTDM | 16% | 14% | 0.7 |
| Δ Creatinine, mmol/L | +3.17 | +1.24 | 0.8 |
| Δ UACR, mg/mol | +0.48 | −5.83 | 0.7 |
| MACE episode | 0% | 3% | 0.1 |
| Patient survival | 97% | 98% | 0.6 |
| Graft survival | 100% | 98% | 0.1 |

Categorical variables are measured at year 3. Abbreviations and definitions: Δ, change from baseline to 3 years; BP, blood pressure; MACE, major adverse cardiovascular event; UACR, urinary albumin-creatinine ratio.
[a]The sample size was 62 (active) and 59 (passive) for all variables other than the last 3.

completion, the overall regression model was not significant but the randomization group significantly predicted weight change (coefficient estimate, −2.88 [95% CI, −5.27 to −0.49]; P = 0.02). Significance was lost if weight change during study was added to the model (coefficient estimate, −2.37 [95% CI, −4.90 to 0.16]; P = 0.07).

We can hypothesize kidney transplant recipients have greater motivation to sustain any BCT, as they worry about developing posttransplant metabolic problems.[6] However, our findings suggest even transplant patients will lapse from any adopted behavior change in the absence of continued intervention. Paradoxically, we observed metabolic improvements over time in the passive arm. This may relate to immunosuppression changes, confounding factors, or lifestyle changes initiated after trial completion owing to study feedback provided to all study participants.

In a systematic review and thematic analysis of qualitative studies exploring motivations, challenges, and attitudes toward self-management among kidney transplant patients, Jamieson et al[7] summarized findings from 50 studies involving 1,238 recipients. They identified 5 important themes important for patient self-management after transplantation: empowerment through autonomy, prevailing fear of consequences, burdensome treatment and responsibilities, overmedicalizing life, and social accountability and motivation.

Therefore, robust BCT adoption and implementation into sustained posttransplant care models needs further investigation. A range of behavior change theories exist, with the ABC of Behaviour Change Theories[8] summarizing 83 different theories comprising more than 1,600 constructs. However, a number of problems concerning incorrect use of theory in the development of behavior change interventions are highlighted. A recent meta-analysis found less than a quarter of implementation studies explicitly used theories of behavior change.[9] The wide range of theories of health behavior contain many overlapping constructs, and so choosing a relevant theory can be difficult for intervention designers. Translating theories to transplant patients will be more challenging, with their greater complexity and substantial burden of care, and requires support and infrastructure.[10]

This analysis explores the sustainability of a post-transplantation BCT beyond the initial delivery. While further research is recommended, with collaboration between transplant professionals and social scientists, our findings suggest incorporating any BCT into posttransplant care must be a continual process rather than a one-off intervention owing to risk of behavior relapse.

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## Supplementary Material

Supplementary File (PDF)

Figures S1-S4; Item S1; Table S1.

## Article Information

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