

MASK IMPACTS ON PHYSIOLOGICAL AND PSYCHOLOGICAL OUTCOMES: META-ANALYSIS AND VISUAL ANALYTICS

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INTRODUCTION

Driven by the concerns raised during the COVID-19 pandemic regarding the **safety and efficacy of wearing face masks during physical activity**, we utilised meta-analysis to investigate the real impact of masks on **physiological and psychological outcomes**.

We utilised the dataset from [Zheng et al. \(2023\)](#) and tested whether higher cardiorespiratory fitness levels influence how masks affect bodily responses, as the physiological demands of athletes may push breathing systems toward their limits more than those of sedentary adults.

METHODOLOGY

Utilising a **random-effects model** based on 45 studies and a total of 1,264 healthy participants, we calculated standardised mean differences (SMD) and 95% confidence intervals for outcomes including **Heart rate**, **Performance**, **Lactate levels**, **Blood oxygen saturation (SpO₂)**, and **Rate of Perceived Exertion (RPE)**. The analysis was conducted in R, featuring forest, funnel, L'Abbé, Baujat, and radial plots to evaluate effect size, heterogeneity and publication bias. Furthermore, we implemented subgroup meta-analyses to determine whether **fitness levels** alter physiological and performance outcomes, while controlling for different mask types.



Trained

VS.



Sedentary

RESULTS AND FINDINGS

Overall, masks **do not cause dangerous physiological changes**, but they do impact subjective experience and peak performance.

Heart rate and blood lactate levels show **no clinically significant shifts** across different fitness levels or mask types. Whilst a statistically observable drop in SpO₂ was noted, levels remained within safe ranges for both subgroups.

However, participants reported a **higher RPE**, indicating that exercise feels more difficult when masked, regardless of fitness level.

Results from the **trained population** are more consistent with lower heterogeneity, meaning these individuals appear to **adapt better to exercising with masks**.

Ultimately, the data suggest that the discomfort felt during masked exercise is **primarily subjective** rather than a result of significant physiological impairment.

Our dataset is built on top of an existing systematic review by Zheng, C., Poon, E. T., Wan, K., Dai, Z., & Wong, S. H (2023). Original dataset: <https://researchdata.cuhk.edu.hk/dataset.xhtml?persistentId=doi:10.48668/WIRVKK&version=1.1>



More about this project:
<https://dsprojects.lib.cuhk.edu.hk/en/projects/mask-impacts/introduction/>
If you would like to reuse the data, please contact data@cuhk.edu.hk.

VISUALISATIONS

Most data points cluster near the zero-effect line of the **radial plot**, indicating that masks generally have a modest impact on **heart rate**. Points scattered outside the central trajectory highlight significant heterogeneity among subgroups, with **lower heterogeneity among trained population**.

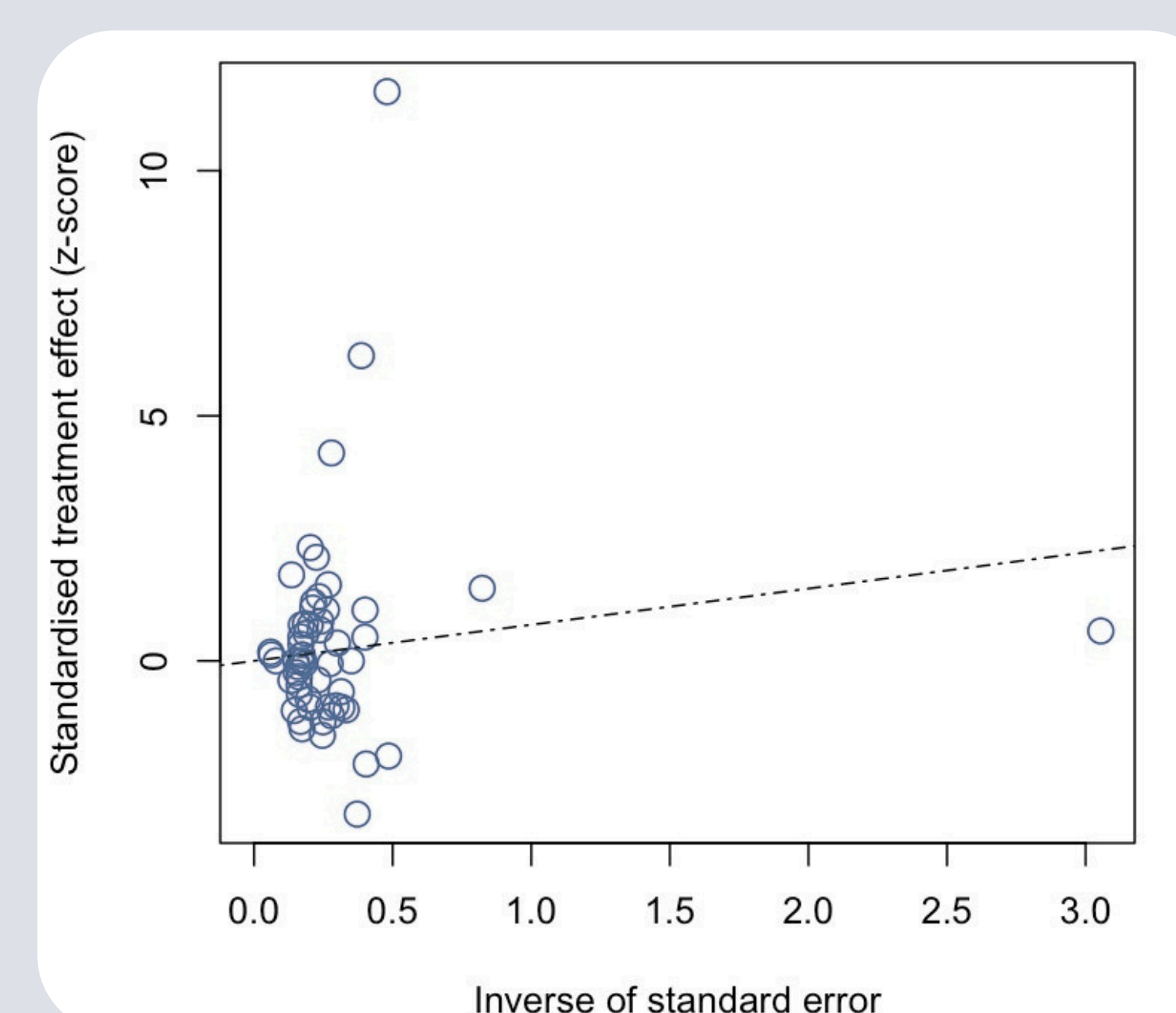


Figure 1. Radial plot of Heart Rate

Mask Type	SMD (95%CI)	I ²	Interpretation (Trained)
Surgical Mask	0.17 [-0.11, 0.45]	50.60%	Trend toward increased heart rate; moderate heterogeneity
FFP2/N95	-0.03 [-0.38, 0.33]	0.00%	Virtually no effect, stable results
Cloth Mask	0.31 [-0.20, 0.83]	-	Single study; insufficient data
Mask Type	SMD (95%CI)	I ²	Interpretation (Sedentary)
Surgical Mask	0.03, [-0.15, 0.22]	50.60%	No significant effect; moderate heterogeneity
FFP2/N95	0.25, [-0.16, 0.67]	76.10%	Trend toward increased heart rate; high heterogeneity
Cloth Mask	-0.22, [-0.72, 0.29]	57.00%	Trend toward decreased heart rate; moderate heterogeneity

Table 1. Standardized Mean Difference of each subgroup

Participants report **higher RPE** when masked, in both sedentary and trained groups.

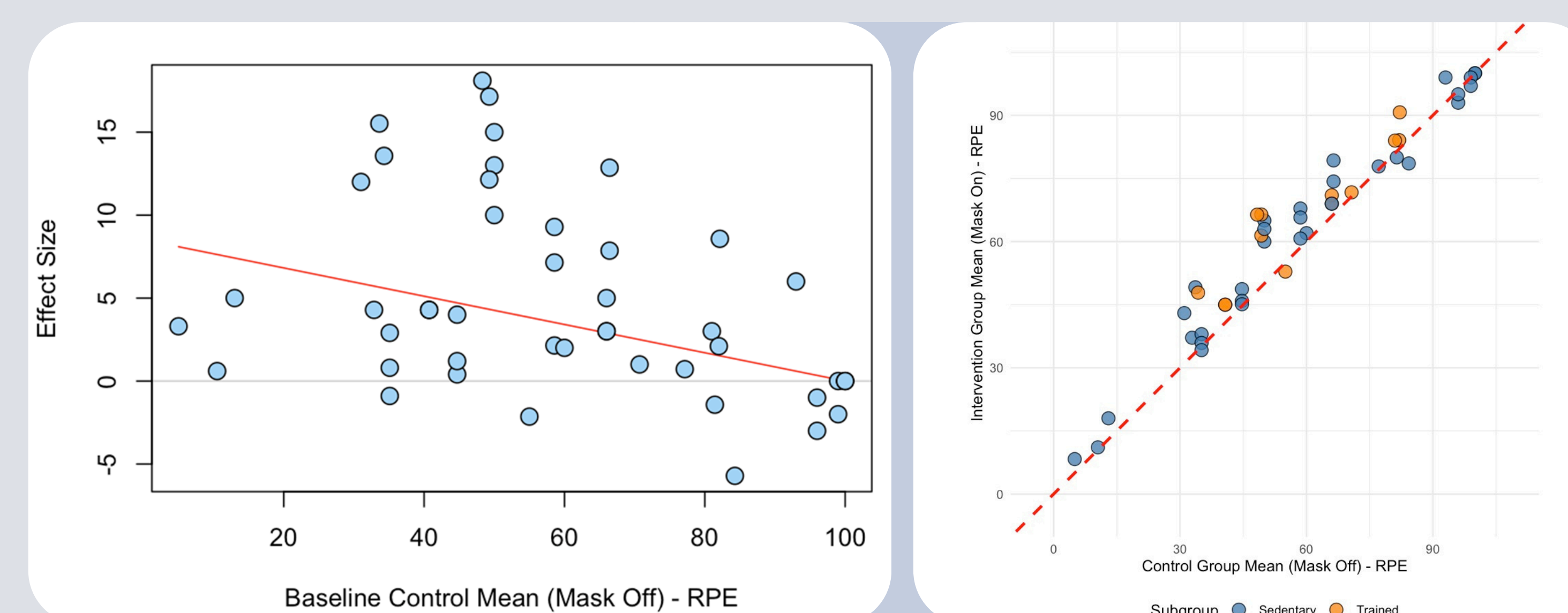


Figure 2&3. Bubble plot and L'Abbé-style Plot of RPE

As baseline SpO₂ (Mask Off) increases, the negative effect of the mask on SpO₂ tends to diminish. Most data points **fall below the zero line**, confirming that masks generally cause a slight decrease in blood oxygen saturation across studies.

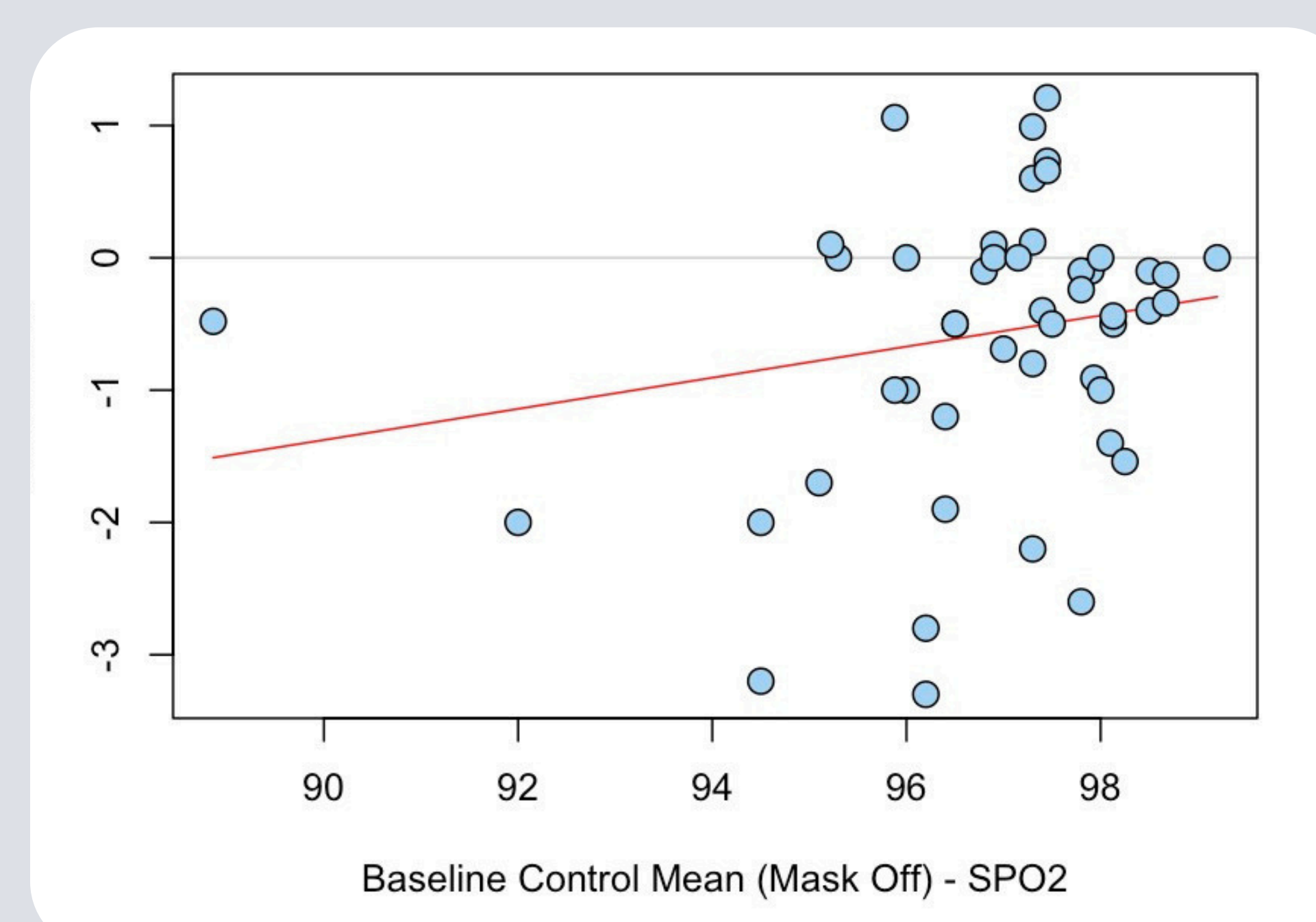


Figure 4. Bubble plot of SPO2