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**Original Article**

# Biofeedback and Caloric Strategies: Enhancing Resilience and Reducing Burnout in Overweight Working Women in Karachi, Pakistan

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## Abstract

**Background:** Obesity is a growing public health challenge, especially among working women, who face unique pressures related to societal expectations and workplace demands. These pressures contribute to stress, burnout, and metabolic health issues, necessitating holistic interventions. This study evaluates the effectiveness of combined caloric restriction and biofeedback, with a focus on empowerment, in enhancing resilience and reducing burnout among overweight working women in Karachi, Pakistan.

**Methodology:** A quasi-experimental interventional study was conducted involving 50 overweight working women (BMI > 25), aged 25–45 years. Participants were divided into two groups: one receiving caloric restriction (CR) alone, and the other receiving caloric restriction combined with biofeedback and empowerment training (CR+B). Key outcomes, including BMI, glucose levels, leptin levels, stress (Perceived Stress Scale), burnout (Burnout Diagnostic Inventory), and societal pressures, were assessed at baseline and post-intervention. Paired t-tests and chi-square tests were applied for statistical analysis.

**Results:** The intervention produced significant improvements across both groups, with greater benefits observed in the CR+B group. Mean BMI decreased from 31.2 to 27.8 kg/m² ($p < 0.03$), fasting glucose levels improved from 118.4 to 96.3 mg/dL ($p < 0.02$), and leptin levels reduced from 25.7 to 16.5 ng/mL ($p < 0.001$). Psychological markers improved significantly, with stress (PSS) scores decreasing by 38.6% and burnout (BDI) scores dropping by 42.1% in the CR+B group ($p < 0.01$). Peer pressure perception decreased by 50%, and workplace productivity increased by 45.7% in the CR+B group ($p < 0.001$).

**Conclusion:** This study highlights the synergistic effects of combining caloric restriction with biofeedback and empowerment strategies. By addressing metabolic health, psychological resilience, and societal pressures, this intervention offers a comprehensive framework for improving the well-being of working women in resource-limited settings.

## Keywords

Biofeedback, Resilience, Caloric Restriction, Working Women, Obesity Management.

## Introduction

Obesity is a complex and multifaceted global health issue, affecting millions worldwide and contributing significantly to the burden of non-communicable diseases (NCDs) such as diabetes, cardiovascular disease, and metabolic syndrome [1,2]. Among women, particularly those in professional roles, the challenges of managing obesity are exacerbated by societal pressures, workplace demands, and caregiving responsibilities[3,4]. In Pakistan, where cultural norms often emphasize traditional gender roles, working women face additional expectations related to appearance and weight, compounding their risk for stress and burnout[5].

Beyond the physiological implications, obesity is deeply intertwined with psychological health. Evidence suggests that societal pressures and weight stigma can lead to chronic stress, low self-esteem, and poor mental health outcomes, including depression and anxiety[6,7]. These psychological stressors not only undermine weight management efforts but also diminish workplace productivity and overall quality of life[8,9]. Thus, addressing obesity in women requires a comprehensive approach that integrates physical, psychological, and social dimensions of health.

Traditional weight management strategies, such as caloric restriction, have proven effective in reducing body weight and improving metabolic parameters. However, these approaches often fail to address the underlying psychological and societal factors contributing to weight gain[10,11]. This gap underscores the need for integrative interventions that include psychological support and empowerment-based strategies. Recent advancements in biofeedback, a technique that trains individuals to control physiological processes such as heart rate variability (HRV) offer promising avenues for enhancing resilience and stress management[11,12]. HRV-based biofeedback, in particular, has been shown to promote autonomic regulation, reduce perceived stress, and improve emotional stability[13,14].

Empowerment-focused interventions, which emphasize self-efficacy, autonomy, and coping skills, have also emerged as effective tools for addressing societal pressures and promoting sustainable behavioral change[14]. Combining biofeedback with such empowerment strategies can create synergistic benefits, addressing both the psychological and metabolic challenges faced by women with obesity.

This study investigates the impact of a combined intervention of caloric restriction, biofeedback, and empowerment training on overweight working women in Karachi, Pakistan. By evaluating key metabolic markers (BMI, glucose, leptin) alongside psychological outcomes (stress, burnout, and societal pressures), this study seeks to provide a holistic framework for health improvement. It also highlights the importance of integrating psychological resilience-building into traditional weight management strategies, offering a model for addressing the unique challenges faced by women in achieving health equity.

## Methodology

### Study Design

This quasi-experimental interventional study was conducted in June 2024 till September 2024. It employed a pre- and post-assessment design to evaluate the effects of a combined biofeedback and caloric restriction intervention on the psychological and metabolic health of overweight working women. A mixed-methods approach was used to assess both objective and subjective outcomes, enhancing the comprehensiveness of the data. Empowerment-focused strategies were integrated, addressing societal pressures, resilience, and workplace productivity, with the aim of improving both psychological well-being and metabolic health.

### Ethics

The study followed ethical guidelines for human research and was approved by the Institutional Review Board (IRB) of the Malir University of Science and Technology MU-IRB/14062024/010, dated 20th June 2024. Written informed consent was obtained from all participants, ensuring

voluntary participation. They were informed of their right to withdraw at any time without penalty. Confidentiality was strictly maintained, with all personal and medical data anonymized during analysis. Ethical considerations ensured that the interventions did not cause undue harm or stress to participants.

**Setting**

The study was conducted within a corporate environment in Karachi, Pakistan, where participants were recruited through workplace health programs in large-scale companies. The intervention was designed to integrate into participants' work schedules, taking into account the societal pressures women face, particularly in terms of workplace stress, social expectations, and the challenge of balancing professional and personal health goals.

**Participants**

Fifty overweight women (BMI > 25) aged 25 to 45 years participated in the study. Participants were recruited from workplace health programs in Karachi, with a focus on those experiencing significant workplace or societal stress. Inclusion criteria included full-time employment, self-reported stress, and a willingness to participate in both biofeedback training and caloric restriction. Exclusion criteria involved individuals with diagnosed psychiatric disorders requiring medication, chronic illnesses that would interfere with dietary restrictions, and pregnant or breastfeeding women.

**Variables**

The study primarily focused on psychological health (stress, burnout, psychological distress) and metabolic health (BMI, glucose metabolism, and hormonal markers such as leptin levels). Secondary variables included workplace performance indicators (e.g., focus, productivity) and societal pressures, particularly regarding weight and appearance.

**Data Sources/Measurement**

Data were collected through both quantitative and qualitative methods. Quantitative data included BMI, fasting blood glucose, leptin levels, and scores from the Perceived Stress Scale (PSS), Burnout Diagnostic Inventory (BDI), and Brief Symptom Inventory (BSI). These measures were taken at both baseline and post-intervention. Qualitative data were collected using a custom-designed questionnaire assessing participants' experiences of societal pressures, mood, confidence, and workplace productivity, with responses rated on a Likert scale.

**Bias**

Potential biases included selection bias, as participants were recruited through workplace health programs, which could limit generalizability. To mitigate this, efforts were made to ensure a diverse sample from various industries. Social desirability bias was addressed by ensuring confidentiality and encouraging honest responses. Measurement bias was minimized by using validated instruments (PSS, BSI) and employing trained personnel for all health assessments.

**Study Size**

The study included 50 participants; a sample size determined by power analysis. This sample size provided sufficient power (80%) to detect moderate effects (Cohen's d = 0.5) with a significance level of 0.05. Given the study's timeframe, this sample size was both feasible and adequate for the planned analyses.

**Statistical Methods**

Paired t-tests were used to compare pre- and post-intervention data for continuous variables, such as BMI, fasting glucose levels, and stress scores. Chi-square tests were applied to categorical data, including the frequency of societal pressures and workplace productivity improvements. Linear regression analyses were conducted to explore the relationships between the intervention components (biofeedback, caloric restriction, and empowerment workshops) and the primary outcomes (BMI, stress, leptin levels). A significance level of $p < 0.05$ was considered statistically significant for all analyses.

# Results

## Participants

The study included 50 overweight working women, with a mean age of 34.6 years (SD = 5.7), ranging from 25 to 45 years. The baseline characteristics of the participants, as shown in Table 1, indicated that the participants had a mean BMI of 31.2 kg/m² (SD = 2.8), suggesting they were overweight. Additionally, participants exhibited moderate levels of perceived stress, as reflected by a mean score of 25.3 (SD = 6.1) on the Perceived Stress Scale (PSS). Their burnout levels, as measured by the Burnout Diagnostic Inventory (BDI), were also high, with a mean score of 63.5 (SD = 12.7), suggesting a baseline risk for burnout. This sample presented an opportunity to assess the impact of the intervention on both psychological and metabolic health.

## Descriptive Data

The baseline data, presented in Table 1, also highlighted other health indicators. The participants' average fasting glucose levels were 118.4 mg/dL (SD = 10.7), indicating suboptimal metabolic health. Additionally, the mean leptin level was 25.7 ng/mL (SD = 5.8), which is consistent with the participants' overweight status and potential metabolic disturbances. Psychological measures revealed that participants had significant psychological distress at baseline, as reflected by their high perceived stress (PSS) and burnout (BDI) scores, pointing to the potential impact of workplace and societal pressures on their mental health.

## Outcome Data

The intervention had a significant effect on various parameters, with improvements observed in both metabolic and psychological health. As shown in Table 2, BMI decreased from a baseline mean of 31.2 kg/m² (SD = 2.8) to 28.6 kg/m² (SD = 2.4), reflecting a significant reduction in body weight ($t = -8.41$, $p < 0.001$). Fasting glucose levels also improved, with a mean reduction from 118.4 mg/dL (SD = 10.7) to 100.2 mg/dL (SD = 8.5) ($t = -5.21$, $p = 0.02$), suggesting enhanced metabolic regulation. The largest effect was seen in leptin levels, which dropped significantly from 25.7 ng/mL (SD = 5.8) to 18.9 ng/mL (SD = 4.3) ($t = -9.13$, $p < 0.001$), indicating hormonal changes in response to the caloric restriction.

In terms of psychological health, perceived stress (PSS) significantly decreased from a baseline score of 25.3 (SD = 6.1) to 17.8 (SD = 4.9) ($t = -7.02$, $p < 0.001$). Similarly, burnout levels decreased from 63.5 (SD = 12.7) to 40.6 (SD = 9.5) ($t = -6.98$, $p = 0.005$), suggesting that both the caloric restriction and biofeedback intervention helped alleviate stress and burnout among the participants. Additionally, the perceived peer pressure, measured on a Likert scale, showed a significant reduction from 4.2 (SD = 0.8) to 2.6 (SD = 0.9) ($t = -4.97$, $p = 0.003$), while productivity at work improved from 3.1 (SD = 0.6) to 4.3 (SD = 0.7) ($t = 6.83$, $p < 0.001$), reflecting enhanced workplace performance.

## Main Results

Table 2 also represent the comparison of the post-intervention results between the two groups caloric restriction (CR) and combined caloric restriction and biofeedback (CR+B) revealed that the CR+B group showed greater improvements across all measured outcomes. The table shows that the CR+B group experienced a more significant reduction in BMI, with a mean of 27.8 kg/m² (SD = 2.3) compared to the CR group's 29.4 kg/m² (SD = 2.5) ($t = -2.23$, $p = 0.03$). Similarly, glucose levels in the CR+B group decreased more markedly, with a mean of 96.3 mg/dL (SD = 7.5) compared to the CR group's 104.7 mg/dL (SD = 9.8) ($t = -2.39$, $p = 0.02$). The CR+B group also had a more pronounced reduction in leptin levels, from 21.3 ng/mL (SD = 5.0) to 16.5 ng/mL (SD = 3.8) ($t = -4.51$, $p < 0.001$).

Psychological improvements were also greater in the CR+B group, with perceived stress (PSS) reducing from 20.1 (SD = 5.0) to 15.5 (SD = 4.0) ($t = -3.14$, $p = 0.01$) and burnout (BDI) decreasing from 45.2 (SD = 10.1) to 36.3 (SD = 8.4) ($t = -2.93$, $p = 0.005$). Furthermore, the CR+B group showed a more significant reduction in peer pressure scores (2.1, SD = 0.6) compared to the CR group (3.2, SD = 0.7) ($t = -3.89$, $p < 0.001$). Workplace

productivity also improved more in the CR+B group, with a mean score of 4.6 (SD = 0.5) compared to the CR group's 3.7 (SD = 0.6) (t = 2.98, p = 0.02).

The categorical analysis of improvements in peer pressure and productivity, as shown in Table 3, revealed significant differences between the two groups. The CR+B group achieved a greater rate of improvement in perceived peer pressure (84%) compared to the CR group (60%) ($\chi^2$ = 8.11, p = 0.01). Similarly, 92% of the CR+B group reported improved productivity, significantly higher than the 68% of the CR group ($\chi^2$ = 9.02, p < 0.001).

These findings emphasize the enhanced efficacy of combining biofeedback with caloric restriction, particularly in terms of reducing societal pressures and improving productivity at work.

**Table 1: Demographic and baseline characteristics of participants.**

| Variables | Mean±SD |
|---|---|
| Age (years) | 34.6±5.7 |
| BMI (kg/m²) | 31.2±2.8 |
| Fatty Liver Index (FLI) | 45.8±10.3 |
| Perceived Stress Scale (PSS) | 25.3±6.1 |
| Burnout Diagnostic Inventory (BDI) | 63.5±12.7 |

**Table 2: Combined Pre- and Post-Intervention Results for CR and CR+B Groups.**

| Variables | | Pre-Intervention Mean±SD | Post-Intervention Mean±SD | [1]p-value | [2]p-value |
|---|---|---|---|---|---|
| **CR Group** | BMI (kg/m²) | 29.4±2.5 | 27.8±2.3 | <0.001* | 0.03* |
| | Glucose Levels (mg/dL) | 104.7±9.8 | 96.3±7.5 | <0.001* | 0.02* |
| | Leptin Levels (ng/mL) | 21.3±5.0 | 16.5±3.8 | <0.001* | <0.001* |
| | Fatty Liver Index (FLI) | 45.0±8.6 | 38.2±7.4 | 0.001* | 0.03* |
| | Perceived Stress Scale (PSS) | 20.1±5.0 | 15.5±4.0 | 0.001* | 0.01* |
| | Burnout Diagnostic Inventory (BDI) | 45.2±10.1 | 36.3±8.4 | 0.002* | 0.005* |
| | Peer Pressure (Likert Scale) | 3.2±0.7 | 2.1±0.6 | 0.001* | <0.001* |
| | Productivity Index (Likert) | 3.7±0.6 | 4.6±0.5 | 0.001* | 0.02* |
| **CR+B Group** | BMI (kg/m²) | 31.2±2.8 | 28.6±2.4 | <0.001* | 0.03* |
| | Glucose Levels (mg/dL) | 118.4±10.7 | 100.2±8.5 | <0.001* | 0.02* |
| | Leptin Levels (ng/mL) | 25.7±5.8 | 18.9±4.3 | <0.001* | <0.001* |
| | Fatty Liver Index (FLI) | 45.8±10.3 | 36.1±8.7 | <0.001* | 0.02* |
| | Perceived Stress Scale (PSS) | 25.3±6.1 | 17.8±4.9 | <0.001* | 0.01* |
| | Burnout Diagnostic Inventory (BDI) | 63.5±12.7 | 40.6±9.5 | <0.001* | 0.005* |
| | Peer Pressure (Likert Scale) | 4.2±0.8 | 2.6±0.9 | <0.001* | <0.001* |
| | Productivity Index (Likert) | 3.1±0.6 | 4.3±0.7 | <0.001* | 0.02* |

*p<0.05 is considered statistically significant

[1]p-value – shows the pre and post intervention comparison

[2]p-value- shows group-wise post-intervention comparison

**Table 3: Comparison of responses of healthcare providers and pregnant women regarding the attitude.**

| Variable | | Improved n(%) | | $\chi^2$ | p-value |
|---|---|---|---|---|---|
| | | Yes | No | | |
| **Peer Pressure** | CR | 15(60) | 10(40) | 6.87 | 0.03* |
| **Improvement** | CR+B | 21(84) | 4(16) | 8.11 | 0.01* |
| **Productivity** | CR | 17(68) | 8(32) | 5.43 | 0.02* |
| **Improvement** | CR+B | 23(92) | 2(8) | 9.02 | <0.001* |

*p<0.05 is considered statistically significant

## Discussion

The findings of this study underscore the effectiveness of combining caloric restriction with biofeedback and empowerment strategies to enhance psychological resilience, reduce burnout, and mitigate societal pressures. These results align with and extend recent research on the holistic benefits of such interventions.

Biofeedback's role in improving resilience through autonomic self-regulation is well-documented [8,15,16,17]. In this study, HRV-based biofeedback facilitated a 29.6% reduction in stress scores, highlighting its ability to promote emotional stability in the face of societal and workplace stressors. Recent models like the Cognitive Affective Model of Immersive Learning (CAMIL) also emphasize the role of self-regulation in fostering long-term behavioral change, reinforcing the findings of this study[5,18].

Burnout reduction remains a critical challenge for working women juggling professional and personal responsibilities[19]. A 36% reduction in burnout scores in this study corroborates findings from other research that biofeedback, when combined with stress management training, significantly reduces occupational stress[20,21]. Participants reported enhanced productivity, a reflection of biofeedback's capacity to improve focus and motivation by addressing underlying stressors[22,23].

Societal expectations regarding body image are pervasive stressors that disproportionately impact women. The 38% reduction in perceived peer pressure among participants underscores the importance of addressing these external stressors in health interventions[24]. Studies have highlighted that societal stressors significantly influence emotional well-being and that empowerment-focused sessions can mitigate these effects[25].

Improvements in metabolic markers, including BMI reduction (2.6 kg/m²) and leptin levels (-26.4%), parallel psychological gains observed in this study. This synergy underscores the interconnectedness of physical and mental health, as also reported in recent literature emphasizing the dual benefits of integrated interventions[26,27].

Empowerment emerged as a critical theme, aligning with evidence that fostering autonomy and self-efficacy enhances adherence to health interventions[28-30]. By addressing societal and personal barriers, the study provided participants with tools for sustainable behavioral change, reinforcing the role of empowerment in achieving health equity.

While this study provides valuable insights, its small sample size and short duration limit generalizability. Future research should explore the long-term effectiveness of such interventions, particularly integrating advanced technologies like VR supported biofeedback to enhance engagement and scalability.

## Conclusion

This study demonstrates that integrating biofeedback and caloric restriction with empowerment strategies produces holistic benefits, addressing both the physical and psychological aspects of health. By directly tackling societal pressures and fostering resilience, this

approach offers a sustainable model for improving the well-being of working women in resource-limited settings. Public health programs should consider such integrative approaches to address the unique challenges faced by women in achieving health equity and empowerment.

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