

**Chancen und Grenzen einer psychologischen mHealth-Intervention  
zur Veränderung dysfunktionalen Essverhaltens  
bei Personen mit Übergewicht und Adipositas**

*Opportunities and limitations of a psychological mHealth intervention  
for modifying dysfunctional eating behavior in individuals with overweight and  
obesity*

**Inaugural-Dissertation  
in der Fakultät Humanwissenschaften  
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vorgelegt von  
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## Vorwort

Die vorliegende Dissertation beinhaltet drei wissenschaftliche Artikel, die sich mit der Beantwortung der Hauptfragestellung auseinandersetzen, ob durch eine psychologische mHealth-Intervention dysfunktionales Essverhalten bei Personen mit Übergewicht und Adipositas verändert werden kann.

Zum Zeitpunkt der Einreichung dieser Dissertation sind zwei der drei Fachartikel bereits in peer-reviewed Journals publiziert worden (Fachartikel 2 und 3). Fachartikel 1 ist zum Zeitpunkt der Einreichung dieser Dissertation bei einem peer-reviewed Journal eingereicht (Status *submitted*).

### ***Fachartikel 1:***

**Färber, T.,** Pape, M., Seiferth, C., Vogel T., Steins-Loeber, S., Herpertz, S., & Wolstein, J. (submitted). Weight bias internalization as a mediator between weight stigma and eating behavior: divergent patterns in individuals with normal weight and individuals with overweight and obesity. *Manuscript submitted for publication*.

### ***Fachartikel 2:***

Pape, M., **Färber, T.,** Seiferth, C., Roth, T., Schroeder, S., Wolstein, J., Herpertz, S., & Steins-Loeber, S. (2022). A tailored gender-sensitive mHealth weight loss intervention (I-GENDO): development and process evaluation. *JMIR Formative Research*, 6(10), e38480. <https://doi.org/10.2196/38480>

### ***Fachartikel 3:***

Seiferth, C.\*, **Färber, T.\***, Pape, M., Schoemann, N., Dieberger, A., Schroeder, S., Herpertz, S., Wolstein, J., & Steins-Loeber, S. (2023). Differential effects of the individualized gender-sensitive mHealth intervention I-GENDO on eating styles in individuals with overweight and obesity—a randomized controlled trial. *BMC Digital Health*, 1(1), 46. <https://doi.org/10.1186/s44247-023-00041-0>

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## **Persönlicher Beitrag zu den Fachartikeln der Dissertation**

Die Artikel sind im Rahmen des vom BMBF geförderten Drittmittelprojekts I-GENDO (Gendersensible Erweiterung herkömmlicher Gewichtsreduktionsprogramme bei Übergewicht und Adipositas: eine personalisierte Smartphone-App) entstanden (Förderzeitraum 2017–2021, Förderkennzeichen 01GL1719A und 01GL1719B). Das Projekt wurde präregistriert (Deutsches Register für Klinische Studien: DRKS00016623, Clinical trials: NCT04080193) und von der Ethik-Kommission der Medizinischen Fakultät der Ruhr-Universität Bochum positiv votiert (Nr: 18-6415). Bei I-GENDO handelte es sich um eine multizentrische randomisierte kontrollierte Studie, die an den Standorten Bamberg (Otto-Friedrich-Universität Bamberg, Lehrstuhl für Klinische Psychologie und Psychotherapie sowie Professur für Pathopsychologie) und Bochum (LWL-Universitätsklinikum Bochum, Klinik für Psychosomatische Medizin und Psychotherapie) durchgeführt wurde.

Tanja Färber war als wissenschaftliche Mitarbeiterin an der Otto-Friedrich-Universität Bamberg an der Konzeption, Durchführung und Auswertung der I-GENDO-mHealth-Intervention beteiligt. Zu den Aufgaben zählten dabei unter anderem die Auswahl und Aufbereitung der App-Inhalte, die Auswahl und Anpassung der Messinstrumente, die Entwicklung der Erhebungs- und Rekrutierungsstrategie sowie die Durchführung der Rekrutierung. Darüber hinaus war sie an der Studiendurchführung, der Betreuung der Studienteilnehmenden, dem Daten- und Prozessmonitoring und der statistischen Analyse der Daten beteiligt. Zudem wirkte sie an der standortübergreifenden Koordination mit.

Im Rahmen der aus der Dissertation hervorgegangenen Fachartikel übernahm Tanja Färber folgende Aufgaben: In Fachartikel 2 war sie als Zweitautorin an der Datenanalyse und -interpretation und an der Erstellung und Überarbeitung des Manuskripts beteiligt. In Fachartikel 3 war sie als Erstautorin für die Datenanalyse und -interpretation zur Beantwortung der spezifischen Forschungsfragen sowie für die Verfassung des Manuskripts zuständig. In Fachartikel 1 entwickelte sie als Erstautorin die Hypothesen für die Fragestellung, rekrutierte eine zusätzliche Vergleichsstichprobe von Personen mit Normalgewicht und passte die Erhebungsinstrumente entsprechend an. Sie war für die zusätzliche Datenerhebung, die Analyse und Interpretation der Daten sowie für die Verfassung des Manuskripts verantwortlich.

## Weitere Publikationen in peer-reviewed Journals

Im Rahmen des Projekts I-GENDO sowie in einem europäischen Gemeinschaftsprojekt I-PREGNO (Prevention of unhealthy weight gain in families in pregnancy and postpartum using a mHealth-enhanced intervention) entstanden folgende weitere Publikationen:

- Pape, M., Herpertz, S., **Färber, T.**, Seiferth, C., Schoemann, N., Wolstein, J., & Steins-Loeber, S. (2025). Food Addiction in Individuals With Overweight and Obesity Undergoing a 12-Week Long Tailored mHealth Weight Loss Intervention. *European Eating Disorders Review*, 33(5), 931-940.
- Henning, C., Seiferth, C., **Färber, T.**, Pape, M., Herpertz, S., Steins-Loeber, S., & Wolstein, J. (2024). Examination of gender differences: Causal attributions of treatment-seeking individuals with overweight and obesity. *Clinical Psychology in Europe*, 6(4), e12089.
- Schoemann, N., Seiferth, C., Pape, M., **Färber, T.**, Herpertz, S., Steins-Loeber, S., & Wolstein, J. (2024). Improving Food-Related Inhibitory Control Through an mHealth Intervention—A Secondary Outcome Analysis of an RCT. *Obesity Science & Practice*, 10(6), e70026.
- Vogel, L., Henning, C., Wolstein, J., Versele, V., Van Poppel, M. N., Steppan, K., Schlossbach, T., Opitz A., Lux U., Löchner, J., **Färber, T.**, & Seiferth, C. (2024). User-centered development process of an evidence-based mHealth intervention for psychosocially burdened families during the transition to parenthood. *Mental Health Science*, 2(2), e58.
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- Vogel, L. \*, **Färber, T.\***, Hölzl, I., Deliens, T., Henning, C., Liel, C., Löchner, J., Lux, U., Opitz, A., Seiferth, C., Versele, V., Wolstein, J., & van Poppel, M. N. (2023). I-PREGNO—prevention of unhealthy weight gain and psychosocial stress in families during pregnancy and postpartum using an mHealth enhanced intervention: a study protocol of two cluster randomized controlled trials. *BMC pregnancy and childbirth*, 23(1), 418.

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- Pape, M., Herpertz, S., Schroeder, S., Seiferth, C., **Färber, T.**, Wolstein, J., & Steins-Loeber, S. (2021). Food addiction and its relationship to weight-and addiction-related psychological parameters in individuals with overweight and obesity. *Frontiers in Psychology*, 12, 736454.

Des Weiteren sind aus anderen Projekten folgende Publikationen entstanden:

- Kreuzer, K., Birkel-Toeglhofer, A. M., Haybaeck, J., Reiter, A., Dalkner, N., Fellendorf, F. T., Maget, A., Platzer, M., Seidl, M., Mendel, L., Lenger, M., Birner, A., Queissner, R., Mairinger, M., Obermayer, A., Kohlhammer-Dorr, A., Stross T., Häussl, A., Hamm, C., Schöggel, H., Amberger-Otti, D., Painold, A., Lahousen-Luxenberger, T., Leitner-Afschar, B., **Färber, T.**, Mörkl, S., Wagner-Skacel, J., Meier-Allard, N., Lackner, S., Holasek, S., Habisch, H., Madl, T., Reininghaus, E., & Bengesser, S. A. (2024). PROVIT-CLOCK: A Potential Influence of Probiotics and Vitamin B7 Add-On Treatment and Metabolites on Clock Gene Expression in Major Depression. *Neuropsychobiology*, 83(3-4), 135-151.
- Kreuzer, K., Reiter, A., Birkel-Töglhofer, A. M., Dalkner, N., Mörkl, S., Mairinger, M., Fleischmann, E., Fellendorf, F., Platzer, M., Lenger, M., **Färber, T.**, Seidl, M., Birner, A., Queissner, R., Mendel, L., Maget, A., Kohlhammer-Dorr, A., Häussl, A., Wagner-Skacel, J., Schöggel, H., Amberger-Otti, D., Painold, A., Lahousen-Luxenberger, T., Leitner-Afschar, B., Haybaeck, J., Habisch, H., Madl, T., Reininghaus, R., & Bengesser, S. (2022). The PROVIT study—Effects of multispecies probiotic add-on treatment on metabolomics in major depressive disorder—A randomized, placebo-controlled trial. *Metabolites*, 12(8), 770.
- Maget, A., Dalkner, N., Hamm, C., Bengesser, S. A., Fellendorf, F. T., Platzer, M., Queissner, R., Birner, A., Lenger, M., Mörkl, S., Kohlhammer-Dohr, A., Rieger, A., Seidl, M., Mendel, L., **Färber, T.**, Wetzlmair, L., Schwalsberger, K., Amberger-Otti, D.V., Schöggel, H., Lahousen, T., & Reininghaus, E. Z. (2021). Sex differences in zonulin in affective disorders and associations with current mood symptoms. *Journal of Affective Disorders*, 294, 441-446.
- Sattler, M. C., **Färber, T.**, Traußnig, K., Köberl, G., Paier, C., Dietz, P., & van Poppel, M. N. (2020). Cross-sectional association between active commuting and perceived commuting stress in Austrian adults: Results from the HOTway study. *Mental Health and Physical Activity*, 19, 100356.

Reiter, A., Bengesser, S. A., Hauschild, A. C., Birkel-Töglhofer, A. M., Fellendorf, F. T., Platzer, M., **Färber, T.**, Seidl, M., Mendel, L., Unterweger, R., Lenger, M., Mörtl, S., Dalkner, N., Birner, A., Queissner, R., Hamm, C., Maget, A., Pilz, R., Kohlhammer-Dohr, A., Wagner-Skacel, J., Kreuzer, K., Schögl, H., Amberger-Otti, D., Lahousen, T., Leitner-Afschar, B., Haybäck, J., Kapfhammer, H-P., & Reininghaus, E. (2020). Interleukin-6 gene expression changes after a 4-week intake of a multispecies probiotic in major depressive disorder—Preliminary Results of the PROVIT Study. *Nutrients*, 12(9), 2575.

## Zusammenfassung

Übergewicht und Adipositas gehen häufig mit körperlichen und psychischen Belastungen einher. Die Prävalenz von Übergewicht und Adipositas hat in den letzten Jahren stark zugenommen und auch für die nächsten Jahre wird ein weiterer Anstieg erwartet, was den dringenden Bedarf an wirksamen und nachhaltigen Interventionsstrategien unterstreicht. Ein zentraler Aspekt für die Entstehung und Aufrechterhaltung von Übergewicht und Adipositas ist das Essverhalten, das in komplexer Weise sowohl durch externe Einflussfaktoren als auch internale psychologische Prozesse und Fähigkeiten beeinflusst wird.

Bestehende Interventionsprogramme zeigen häufig nur kurzfristige Effekte, was womöglich darauf zurückzuführen ist, dass zentrale psychologische Faktoren, wie beispielsweise Emotionsregulation oder besondere Kontextfaktoren, wie gewichtsbezogene Stigmatisierungserfahrungen nur unzureichend berücksichtigt werden oder die Maßnahmen unzureichend auf die betroffene Person zugeschnitten werden. Mobile Health (mHealth)-Interventionen bieten hier ein besonderes Potenzial, da sie niedrigschwellig, flexibel einsetzbar und durch technische Möglichkeiten auch individualisierbar sind.

Die vorliegende Dissertation nimmt an, dass eine nachhaltige Veränderung dysfunktionalen Essverhaltens nur durch die gezielte Bearbeitung zugrunde liegender psychologischer Prozesse möglich ist und damit auch die Grundlage für eine langfristige Stabilisierung des Körpergewichts schafft. Zur Prüfung dieser Annahme untersucht diese Arbeit die psychologische mHealth-Intervention *I-GENDO* bei Personen mit Übergewicht und Adipositas. Drei Studien beleuchten komplementäre Aspekte der zentralen Forschungsfrage, ob dysfunktionales Essverhalten durch eine psychologische mHealth-Intervention nachhaltig verändert werden kann.

**Studie 1** untersucht in einer Stichprobe von  $n = 213$  Personen mit Übergewicht und Adipositas ( $M_{\text{BMI}} = 33,35$ ,  $SD_{\text{BMI}} = 3,79$ ) sowie in einer Vergleichsstichprobe von  $n = 119$  Personen mit Normalgewicht ( $M_{\text{BMI}} = 22,08$ ,  $SD_{\text{BMI}} = 1,91$ ) gewichtsbezogene Stigmatisierungserfahrungen, Selbststigmatisierung und Essverhalten. Die Ergebnisse zeigen, dass Stigmatisierung und Selbststigmatisierung in beiden Gruppen auftreten und mit dysfunktionalem Essverhalten assoziiert sind. Selbststigmatisierung vermittelt unabhängig vom BMI den Zusammenhang zwischen Stigmatisierungserfahrungen und emotionalem Essverhalten und erklärt bei Personen mit Normalgewicht zusätzlich die Beziehung zu einem womöglich vor einer Gewichtszunahme schützenden Essverhalten, dem restriktivem Essverhalten. Die Befunde verdeutlichen die

Bedeutung psychosozialer Faktoren für die Entstehung und Aufrechterhaltung dysfunktionalen Essverhaltens.

**Studie 2** beschreibt die Entwicklung und Gestaltung der I-GENDO-App sowie die individualisierte Zuweisung von Interventionsmodulen basierend auf psychologischen Ausgangsvariablen. Die Auswertung der Nutzungsdaten von  $N = 116$  Personen mit Übergewicht und Adipositas ( $M_{BMI} = 33,58$ ,  $SD_{BMI} = 3,79$ ) zeigt eine Heterogenität in der Modulzuweisung und bestätigt den Bedarf einer individualisierten Zuordnung von Interventionsinhalten.

**Studie 3** prüft die Wirksamkeit der I-GENDO-App zur Veränderung emotionalen, restriktiven und externalen Essverhaltens in einer randomisierten kontrollierten Studie mit  $N = 213$  Personen mit Übergewicht und Adipositas ( $M_{BMI} = 33,35$ ,  $SD_{BMI} = 3,79$ ). Die Ergebnisse belegen signifikante und langfristig stabile Verbesserungen von restriktivem Essverhalten sowohl unmittelbar nach der 12-wöchigen Intervention als auch 9 Monate nach Interventionsbeginn. Für emotionales und externes Essverhalten zeigen sich hingegen gemischte Effekte. Dies deutet darauf hin, dass die Intervention spezifische kognitive Prozesse wirksam adressiert, während andere Prozesse, insbesondere jene, die emotionales Essverhalten beeinflussen, möglicherweise eine intensivere oder persönlich begleitete Intervention erfordern.

Die Studien verdeutlichen, dass psychosoziale Faktoren wie Stigmatisierung das Essverhalten wesentlich beeinflussen können und dass individualisierte mHealth-Interventionen an psychologischen Ausgangsbedingungen ansetzen und insbesondere restriktives Essverhalten nachhaltig verbessern können. Zur Veränderung emotionalen Essverhaltens können digitale Interventionen nicht oder nur als Ergänzung zu weiteren bestehenden Interventionsformen empfohlen werden. Insgesamt bestätigen die Ergebnisse, dass eine alltagsnahe, psychologisch fundierte und individualisierte Intervention ein erhebliches Potenzial für nachhaltige Verhaltensänderungen bei Personen mit Übergewicht und Adipositas besitzt.

## Abstract

Overweight and obesity are often accompanied by physical and psychological stress. The prevalence of overweight and obesity has increased significantly in recent years and is expected to continue rising, underscoring the urgent need for effective and sustainable intervention strategies. A key factor in the development and maintenance of overweight and obesity is eating behavior, which is shaped in complex ways by both external influences and internal psychological processes and skills.

Many existing intervention programs often show only short-term effects. This may be due to the insufficient consideration of key psychological factors such as emotion regulation, and relevant contextual influences such as stigmatization, or to a lack of adequate individual tailoring of interventions. Mobile Health (mHealth) interventions offer particular potential in this regard, as they are easily accessible, flexible in their application, and can be highly individualized through technical possibilities.

This dissertation is based on the assumption that sustainable change in dysfunctional eating behavior is only achievable through the targeted treatment of underlying psychological processes, thereby also providing a foundation for long-term weight stabilization. To test this assumption, the present work examines the psychological mHealth intervention *I-GENDO* in individuals with overweight and obesity. Three studies address complementary aspects of the central research question of whether dysfunctional eating behavior can be sustainably modified through a psychological mHealth intervention.

**Study 1** examines a sample of  $n = 213$  individuals with overweight and obesity ( $M_{\text{BMI}} = 33.35$ ,  $SD_{\text{BMI}} = 3.79$ ) and a comparison sample of  $n = 119$  individuals with normal weight ( $M_{\text{BMI}} = 22.08$ ,  $SD_{\text{BMI}} = 1.91$ ). The results show that stigmatization and self-stigmatization occur in both groups and are associated with dysfunctional eating behavior. Self-stigmatization mediates the relationship between experienced stigmatization and emotional eating, independent of BMI. In individuals with normal weight, it additionally explains the association with eating behaviors that may protect against weight gain, namely restrained eating. These findings highlight the importance of psychosocial factors in the development and maintenance of dysfunctional eating behavior.

**Study 2** describes the development of the *I-GENDO* app and the individualized allocation of intervention modules based on psychological baseline variables. An analysis of usage data from  $N = 116$  individuals with overweight and obesity ( $M_{\text{BMI}} = 33.58$ ,  $SD_{\text{BMI}} = 3.79$ ) shows that

different psychological profiles systematically lead to differentiated module assignments and underscores the relevance of individualized intervention content.

**Study 3** examines the effectiveness of the I-GENDO app in modifying emotional, restrained, and external eating behavior in a randomized controlled trial with  $N = 213$  individuals with overweight or obesity ( $M_{BMI} = 33.35$ ,  $SD_{BMI} = 3.79$ ). The results show significant and long-term stable improvements in restrained eating behavior both immediately after the 12-week intervention and 9 months after the start of the intervention. For emotional and external eating behavior, however, heterogeneous effects are observed. This suggests that the intervention effectively addresses specific cognitive processes, while other processes, particularly those underlying emotional eating, may require more intensive or personally guided interventions.

Overall, the studies demonstrate that psychosocial factors such as stigmatization can substantially influence eating behavior, that individualized mHealth interventions can address psychological baseline characteristics, and that such interventions can lead to sustained improvements in restrained eating behavior. Digital interventions cannot currently be recommended as stand-alone treatments for emotional eating and should instead be considered as a supplement to established intervention approaches. Taken together, the results confirm that practical, psychologically grounded and individualized interventions have considerable potential to promote sustainable behavioral change in individuals with overweight and obesity.

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## Abkürzungsverzeichnis

|         |                                                                                                                                          |
|---------|------------------------------------------------------------------------------------------------------------------------------------------|
| AGG     | Allgemeines Gleichbehandlungsgesetz                                                                                                      |
| BMI     | Body-Mass-Index                                                                                                                          |
| I-GENDO | Gendersensible Erweiterung herkömmlicher Gewichtsreduktionsprogramme bei Übergewicht und Adipositas: eine personalisierte Smartphone-App |
| mHealth | Mobile Health                                                                                                                            |
| RCT     | Randomisierte kontrollierte Studie                                                                                                       |
| WHO     | Weltgesundheitsorganisation                                                                                                              |

# 1 Theoretischer Hintergrund

## 1.1 Epidemiologie und Ätiologie der Adipositas

### **Begriffsbestimmung und Epidemiologie**

Die Weltgesundheitsorganisation (WHO) definiert Adipositas als „abnorme oder übermäßige Fettansammlung, die ein Gesundheitsrisiko darstellt“ (WHO, 2025) und verweist auf damit verbundene körperliche Erkrankungen, zu denen unter anderem Diabetes Typ 2, Herzerkrankungen und ein erhöhtes Krebsrisiko zählen. Zur Klassifizierung von Körpergewicht wird der Body-Mass-Index (BMI) verwendet, der sich aus dem Körpergewicht geteilt durch das Quadrat der Körpergröße ( $\text{kg/m}^2$ ) ergibt. Ein BMI von 18,5 bis 24,9 gilt als Normalgewicht, unter 18,5 als Untergewicht. Übergewicht liegt ab einem BMI von 25,0 vor, Adipositas ab 30,0. Diese wird in drei Grade unterteilt: Grad 1 (30,0–34,9), Grad 2 (35,0–39,9) und Grad 3 ( $\geq 40,0$ ).

Weltweit hat sich die Prävalenz von Adipositas zwischen 1990 und 2022 verdoppelt (WHO, 2025). In Deutschland weist mehr als die Hälfte der Bevölkerung Übergewicht (inklusive Adipositas) und 19% Adipositas auf (Schienkiewitz et al., 2022). Übergewicht und Adipositas gehen neben einem erhöhten Risiko für die Entwicklung komorbider körperlicher Erkrankungen auch mit einer hohen psychischen Belastung einher. Zu den möglichen Folgen zählen eine verringerte Lebensqualität, höhere Körperunzufriedenheit oder ein erhöhtes Risiko für psychische Erkrankungen wie Depressionen oder Essstörungen (Chu et al., 2019). Gemäß den Prognosen der WHO ist auch in den kommenden Jahren mit einem weiteren Anstieg von Adipositas in der Bevölkerung zu rechnen (WHO, 2025), was die Entwicklung und Optimierung effektiver Behandlungsansätze dringend erforderlich macht.

## Ätiologie der Adipositas

Körpergewicht wird von einer Vielzahl biopsychosozialer Faktoren beeinflusst und stellt ein komplexes, multifaktorielles Bedingungsgefüge dar (Candib, 2007; Endalifer & Diress, 2020; Masood & Moorthy, 2023). Das *biopsychosoziale Modell der Entstehung und Aufrechterhaltung von Übergewicht und Adipositas* (Lehrke & Laessle, 2009) identifiziert relevante Einflussgrößen auf mehreren Ebenen (siehe Abbildung 1).

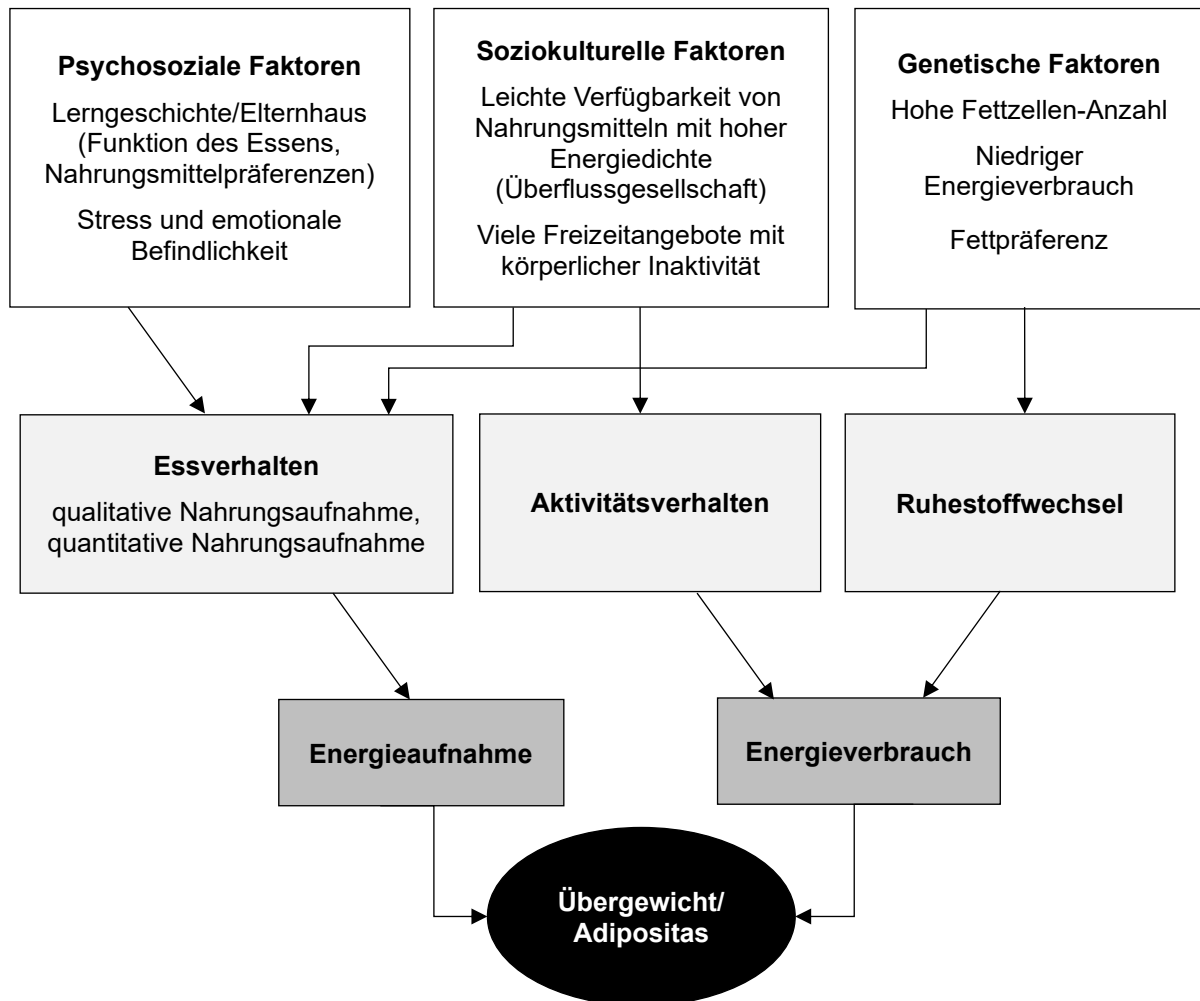


Abbildung 1. Das biopsychosoziale Modell der Entstehung und Aufrechterhaltung von Übergewicht und Adipositas (Lehrke & Laessle, 2009, S.24).

Demnach resultiert das Körpergewicht aus der Bilanz zwischen Energieaufnahme und -verbrauch, welche durch das Essverhalten, das Aktivitätsverhalten und die Stoffwechselfunktionen einer Person bestimmt wird. Die Entwicklung des Ess- und Bewegungsverhaltens wird wiederum maßgeblich von psychosozialen und soziokulturellen Faktoren beeinflusst, wobei auch genetische Einflüsse eine Rolle spielen. Bestimmte Gene

gelten als begünstigend für die Entwicklung von Adipositas, insbesondere in Interaktion mit weiteren Risikofaktoren (Rohde et al., 2019).

Zu den soziokulturellen Einflussgrößen zählt vor allem das Leben in einer zunehmend obesogenen Umwelt (Giskes et al., 2011). So können das Überangebot an Nahrungsmitteln, ihre zunehmend leichtere Verfügbarkeit sowie steigende Portionsgrößen das Essverhalten ungünstig beeinflussen (Nicolaidis, 2019). Gleichzeitig geht eine zunehmend inaktive Freizeitgestaltung, etwa durch längere Nutzungszeiten von Fernsehen oder Smartphone, mit einer Verringerung der körperlichen Aktivität einher (Nicolaidis, 2019). Darüber hinaus spielen auch Merkmale der Wohnumgebung eine Rolle, da eine geringere Anzahl an Rad- und Gehwegen oder Grünflächen mit niedrigerer körperlicher Aktivität assoziiert sein kann (Jia et al., 2023). Zudem bestehen negative Zusammenhänge zwischen Einkommen, Bildung und dem Auftreten von Adipositas (Nicolaidis, 2019).

Neben diesen soziokulturellen Aspekten wirken sich auch psychosoziale Faktoren auf das Ess- und Bewegungsverhalten aus. Insbesondere Stress stellt hierbei eine zentrale Einflussgröße dar (Tomiya, 2019). Darüber hinaus können weitere psychische Belastungen, wie depressive Symptome, ein niedriger Selbstwert oder Probleme mit dem eigenen Körperbild mit höherem Körpergewicht assoziiert sein (Robinson et al., 2020). Auch früh erlernte maladaptive Bewältigungsstrategien, wie emotionales Essen, bei dem Essen zur Regulierung von Emotionen eingesetzt wird, können ebenfalls zu einer Gewichtszunahme beitragen (van Strien, 2018).

## 1.2 Dysfunktionales Essverhalten bei Übergewicht und Adipositas

Essverhalten ist ein komplexes Konstrukt, das nicht nur durch die Auswahl der Nährstoffe oder die aufgenommene Menge beschrieben werden kann. In den letzten Jahrzehnten hat sich insbesondere das Wissen über emotionale und kognitive Vorgänge, die dem Essverhalten zugrunde liegen, erweitert, was sich in einer Vielzahl verfügbarer diagnostischer Instrumente und Erfassungsmöglichkeiten verschiedener Essverhaltensweisen widerspiegelt (Meule, 2020). Drei bei Adipositas häufig untersuchte Ausprägungen sind emotionales, restriktives und externes Essverhalten.

*Emotionales Essverhalten* beschreibt das Essen als Reaktion auf Gefühle wie beispielsweise Trauer oder Ärger (van Strien et al., 1986). Studien zeigen, dass besonders emotionales Essverhalten bei Personen mit Übergewicht und Adipositas stärker ausgeprägt ist als bei Personen mit Normalgewicht (van Strien, 2018; Vasileiou & Abbott, 2023) und mit geringeren Emotionsregulationsfähigkeiten (Gianini et al., 2013) einhergeht. Zudem wurden Zusammenhänge mit höherer Impulsivität (Micanti et al., 2017; Rose et al., 2018), erhöhter Belohnungssensitivität (Sutton et al., 2022) und geringeren Inhibitionsfähigkeiten festgestellt (Arexis et al., 2023).

Neben einer hohen Ausprägung emotionalen Essens liegen auch Befunde für die Bedeutung restriktiven Essverhaltens bei Übergewicht und Adipositas vor (Burton et al., 2007; van Strien et al., 2009). *Restriktives Essverhalten* beschreibt das gezielte Einschränken der Nahrungsmittelaufnahme, beispielsweise zur Gewichtskontrolle (van Strien et al., 1986). Es kann vor einer Gewichtszunahme schützen (van Strien et al., 2009), wobei ausschließlich eine flexible Einschränkung als funktional gilt, während ein rigides Einschränken als dysfunktional angesehen wird (Schaumberg et al., 2016; Westenhoefer et al., 2013). Um restriktives Essverhalten aufbringen zu können, sind vor allem Fähigkeiten wie Selbstkontrolle (Georgii et al., 2020) oder Selbstwirksamkeitserleben nötig (Bas & Donmez, 2009; Linardon, 2018).

*Externales Essverhalten* beschreibt Essen als Reaktion auf externe Hinweisreize, etwa Geruch oder Aussehen von Lebensmitteln (van Strien et al., 1986). Die Studienlage ist hierzu inkonsistent: Während einige Untersuchungen einen Zusammenhang zwischen stärker ausgeprägtem externalen Essverhaltens und höherem BMI zeigen konnten (Burton et al., 2007), fanden andere Studien keine entsprechenden Zusammenhänge (van Strien et al., 2009). Die Fähigkeit, weniger stark auf externe Essensreize zu reagieren, hängt unter anderem von der

interozeptiven Wahrnehmung (Erkennen von Hunger- und Sättigungszuständen) (Herbert, 2021) sowie von Aufmerksamkeitslenkung und Impulskontrolle ab (Hou et al., 2011).

Insgesamt zeigen die Befunde, dass dysfunktionales Essverhalten eng mit intrapsychischen Prozessen und individuellen psychologische Fähigkeiten verknüpft ist (Arexis et al., 2023; Bas & Donmez, 2009; Gianini et al., 2013; Herbert, 2021; Hou et al., 2011; Linardon, 2018; Micanti et al., 2017). Ein vertieftes Verständnis dieser Zusammenhänge ist daher zentral, um die Entstehung und Aufrechterhaltung dysfunktionalen Essverhaltens zu erklären und daraus gezielte, evidenzbasierte Interventionen abzuleiten.

### 1.3 Gewichtsbezogene Stigmatisierung und Internalisierung

Neben internalen Faktoren (siehe Kapitel 1.2) kann das Essverhalten auch durch externe Faktoren beeinflusst werden. Ein besonders bedeutsamer Faktor ist gewichtsbezogene Stigmatisierung, die viele Personen mit Übergewicht und Adipositas erfahren (Prunty et al., 2020; Spahlholz et al., 2016).

#### **Gewichtsbezogene Stigmatisierung**

Das Stigma von Übergewicht und Adipositas umfasst die Zuschreibung negativ besetzter Eigenschaften wie Faulheit, Motivationslosigkeit oder Inkompetenz (Puhl & Heuer, 2009). Stigmatisierung kann in allen Bereichen des alltäglichen Lebens stattfinden: Sie kann sich beispielsweise in negativen Kommentaren innerhalb der Familie oder der Peer-Gruppe, in Benachteiligungen am Arbeitsplatz oder im Bewerbungsprozess, in unzureichenden Untersuchungen im Gesundheitssektor oder in einseitigen Darstellungen von Schauspielerinnen und Schauspielern mit Übergewicht und Adipositas in Film und Fernsehen („der Kumpeltyp“, „die Lustige“) zeigen (Ata & Thompson, 2010; Puhl & Heuer, 2009; Puhl & King, 2013; Spahlholz et al., 2016). Gewichtsbezogene Abwertungen betreffen insgesamt vor allem Personen mit Übergewicht und Adipositas, können jedoch auch bei Personen mit Normalgewicht vorkommen (Prunty et al., 2020). In vielen Fällen geht Stigmatisierung über soziale Abwertungen hinaus und äußert sich in diskriminierendem Verhalten. Die Diskriminierung von Personen mit Übergewicht und Adipositas tritt sogar in ähnlicher Häufigkeit auf wie Diskriminierung aufgrund von Geschlecht oder Herkunft (Puhl et al., 2008). Im Vergleich zu anderen Diskriminierungsformen besteht in Deutschland jedoch kein gesetzlicher Schutz vor Diskriminierung aufgrund des Körpergewichts, da das Allgemeine Gleichbehandlungsgesetz dies nicht abdeckt (Antidiskriminierungsstelle des Bundes, 2023). Die Zuschreibung der Entstehung von Übergewicht und Adipositas auf wenige Eigenschaften wie Willenskraft oder Anstrengung greift zu kurz und spiegelt das komplexe Bedingungsgefüge keineswegs wider. Die vereinfachte Ursachenzuschreibung trägt dazu bei, dass das Stigma in der Gesellschaft hartnäckig bestehen bleibt (Puhl et al., 2015; Puhl & Heuer, 2009; Westbury et al., 2023). Das Stigma ist sogar so weit verbreitet und internalisiert, dass es auch innerhalb der Gruppe von Personen mit Übergewicht zu finden ist: Personen mit Übergewicht und Adipositas können selbst die eigenen Gruppenmitglieder implizit abwerten, ein Phänomen, das als in-group bias bezeichnet wird (Wang et al., 2004).

Gewichtsbezogene Stigmatisierung und Diskriminierung gehen mit einer Vielzahl negativer Folgen einher, darunter erhöhter psychischer Stress, Angst, ein niedrigeres Selbstwertgefühl und eine höhere Körperunzufriedenheit (Alimoradi et al., 2020; Papadopoulos & Brennan, 2015). Das Erleben gewichtsbezogener Stigmatisierung steht zudem in Zusammenhang mit dysfunktionalem Essverhalten, insbesondere emotionalem Essverhalten (Vartanian & Porter, 2016). Pearl et al. (2020) gehen sogar davon aus, dass Stigmatisierungserleben ein hoch relevanter psychosozialer Faktor ist, der zur Entstehung und Aufrechterhaltung von Adipositas beiträgt. Tomiyama (2014) beschreibt hierzu ein Teufelskreismodell. Demnach führt Stigmatisierung zu körperlichem und psychischem Stress, der durch einen Cortisolanstieg vermittelt wird. Dies erhöht die Wahrscheinlichkeit, dass Essen als maladaptiver Bewältigungsmechanismus zur Selbstberuhigung eingesetzt wird. Die dadurch resultierende Gewichtszunahme steigert wiederum das Risiko weiterer Stigmatisierungserfahrungen (Tomiyama, 2014) (siehe Abbildung 2).

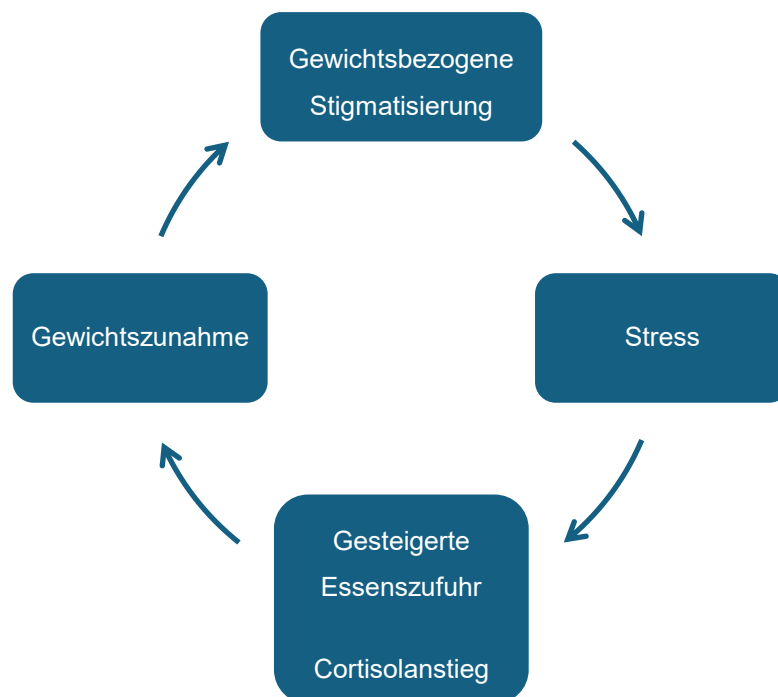


Abbildung 2. Teufelskreis gewichtsbezogener Stigmatisierung, in Anlehnung an Tomiyama (2014).

Zusätzlich kann gewichtsbezogenes Stigmatisierungserleben zu Vermeidungsverhalten hinsichtlich gesundheitsförderlicher Aktivitäten führen. Betroffene vermeiden beispielsweise Arztbesuche oder Sportangebote, nur um potenziellen Stigmatisierungs- oder Diskriminierungssituationen aus dem Weg zu gehen (Major et al., 2018).

## **Internalisierung gewichtsbezogener Stigmatisierung**

Die Internalisierung von Stigmatisierung bzw. Selbststigmatisierung beschreibt den Prozess, bei dem sich von Übergewicht oder Adipositas betroffene Personen gesellschaftliche Stigmata selbst zuschreiben (englisch: *weight bias internalization* oder *self-stigma*) (Durso & Latner, 2008). Dies kann dazu führen, dass sie sich im Vergleich zu anderen Personen beispielsweise selbst als „inkompetenter“, „fauler“ oder „weniger beliebt“ wahrnehmen.

Aktuelle Studien betonen wiederholt, dass die Internalisierung von Stigmatisierung eine vermittelnde Rolle bei den negativen psychischen Konsequenzen spielt, die mit gewichtsbezogener Stigmatisierung einhergehen können (Pearl et al., 2020). Gemäß den Arbeiten von Pearl et al. (2020) ist dabei neben dem tatsächlichen Erleben von Stigmatisierungen entscheidend, in welchem Ausmaß Betroffene diese negativen Zuschreibungen internalisieren und sich somit selbst stigmatisieren. Die Internalisierung der mit dem Stigma verbundenen Attribute kann dabei sogar allein durch gesellschaftliche Vorannahmen, Beobachtungen oder mediale Darstellungen entstehen. Eigene direkte Erfahrungen mit Stigmatisierung oder Diskriminierung sind hierfür also nicht zwingend erforderlich (Puhl et al., 2018). Studien belegen ebenfalls Zusammenhänge zwischen einer stärkeren Internalisierung von Stigmatisierung und der Ausprägung dysfunktionalen Essverhaltens, wie emotionalem Essverhalten oder dem Auftreten von Essattacken (Pearl & Puhl, 2018). Zudem sind in Interventionen zur Gewichtsreduktion geringere Erfolge mit einer höheren Ausprägung von Selbststigmatisierung assoziiert (Pearl & Puhl, 2018).

## 1.4 Behandlungsansätze

Durch das komplexe Bedingungsgefüge der Entwicklungs- und aufrechterhaltenden Faktoren von Adipositas ergeben sich auf verschiedenen Ebenen zahlreiche Ansatzmöglichkeiten für Prävention und Intervention (Candib, 2007). Diese können sowohl auf individuelle Faktoren wie das Essverhalten, auf Aspekte der Lebensumwelt, wie die Wohnumgebung, als auch auf struktureller oder politischer Ebene, beispielsweise in Form von Ernährungsempfehlungen, abzielen (Deutsche Adipositas-Gesellschaft (DAG) e.V., 2024). Viele der für Übergewicht und Adipositas relevanten Einflussfaktoren erweisen sich jedoch als nur schwer oder gar nicht veränderbar, wie etwa genetische Faktoren oder Merkmale der direkten Wohnumgebung (Candib, 2007; Endalifer & Diress, 2020; Sansbury & Hill, 2014).

Gemäß der S3-Leitlinie zur Prävention und Therapie der Adipositas ist eine Behandlung bei einem BMI  $\geq 30,0$  kg/m<sup>2</sup> indiziert oder auch bereits ab einem BMI  $\geq 25,0$  kg/m<sup>2</sup>, wenn körperliche Begleiterkrankungen wie Diabetes mellitus oder Bluthochdruck vorliegen, bzw. durch das Übergewicht verschlimmert werden. Auch bei einer stammbetonten Fettverteilung oder einer hohen psychosozialen Belastung wird die Behandlung des Übergewichts empfohlen (DAG, 2024). Das primäre Ziel der Behandlung von Übergewicht und Adipositas ist die Gewichtsreduktion. Bereits eine Reduktion des Körpergewichts um 5% kann zu signifikanten Verbesserungen der körperlichen Gesundheit sowie zu einer Steigerung des psychischen Wohlbefindens führen (Horn et al., 2022; Magkos et al., 2016; Ryan & Yockey, 2017). Die aktuelle S3-Leitlinie empfiehlt hierfür eine multimodale Basistherapie, bestehend aus Ernährungstherapie, Bewegungstherapie und Verhaltensmodifikation (DAG, 2024).

Darüber hinaus stehen weitere Therapieansätze zur Verfügung, die eine Gewichtsreduktion unterstützen können, darunter die Pharmakotherapie mit Wirkstoffen wie Orlistat, Liraglutid, Bupropion und Naltrexon (Khalil et al., 2020) sowie Semaglutid (Tan et al., 2022) oder die Adipositas- und metabolische Chirurgie (Cosentino et al., 2021). Diese ergänzenden Therapieansätze werden jedoch stets in Kombination mit einer parallelen multimodalen Basistherapie empfohlen (DAG, 2024).

## **Lifestyle-Interventionen**

Die Kombination aus Ansätzen zur Veränderung des Ernährungs- oder Bewegungsverhaltens sowie der Einsatz kognitiv-behavioraler Therapieelemente zur Verhaltensmodifikation sind typische Bestandteile sogenannter Lifestyle-Interventionen bei Übergewicht und Adipositas (Olson et al., 2017). Die kognitiv-verhaltenstherapeutischen Elemente von Lifestyle-Interventionen zielen häufig darauf ab, die Umsetzung von Ernährungs- oder Bewegungsempfehlungen zu unterstützen (Olson et al., 2017). Zu den typischen Elementen zählen dabei unter anderem die Selbstbeobachtung des eigenen Verhaltens, das Setzen realistischer Ziele, die Verbesserung von Problemlösefähigkeiten, Stimuluskontrolle, die Förderung sozialer Kompetenzen sowie Rückfallprophylaxe (Lv et al., 2017; Olson et al., 2017). Die Studienlage spricht insgesamt für die Wirksamkeit dieser kombinierten Ansätze. So zeigen Studien, dass Lifestyle-Interventionen hinsichtlich eines Gewichtsverlusts effektiver sind als Interventionen, die lediglich einen dieser Aspekte adressieren (Puente & Martínez-Marcos, 2018). Gleichzeitig bestehen jedoch Herausforderungen hinsichtlich ihrer langfristigen Effektivität (Webb & Wadden, 2017).

Vor diesem Hintergrund rücken die Mechanismen erfolgreicher langfristiger Gewichtsstabilisierung zunehmend in den Fokus der Forschung. Insbesondere die Veränderung spezifischer Essverhaltensweisen gilt als relevant für eine langfristige Gewichtsabnahme beziehungsweise -stabilisierung. Dabei werden vor allem die Förderung eines flexibel gezügelten Essverhaltens (Teixeira et al., 2015) sowie die Reduktion emotionalen Essverhaltens (Teixeira et al., 2010) hervorgehoben. Darüber hinaus zeigt eine systematische Übersichtsarbeit von Teixeira et al. (2015), dass auch psychologische Faktoren wie intrinsische Motivation, Selbstregulationsfähigkeit, Selbstwirksamkeitserleben und eine positive Einstellung zum eigenen Körperbild maßgeblich zur Aufrechterhaltung gesundheitsbezogenen Verhaltens beitragen (Teixeira et al., 2015). Auch Varkevisser et al. (2019) betonen die Bedeutung von Selbstwirksamkeitserleben und Körperakzeptanz als relevante Prädiktoren der Gewichtsstabilisierung. Insgesamt lassen diese Befunde vermuten, dass eine nachhaltige Wirksamkeit von Lifestyle-Interventionen wesentlich von der Berücksichtigung und gezielten Bearbeitung zugrunde liegender psychologischer Faktoren abhängen könnte.

## Chancen von mHealth-Interventionen

In den letzten Jahren ist die Zahl mobiler Gesundheitsanwendungen, sogenannter mHealth-Interventionen, in verschiedenen Gesundheitsbereichen, einschließlich der Behandlung von Übergewicht und Adipositas, stark angestiegen (Marcolino et al., 2018). Im Vergleich zu klassischen, das heißt analogen Lifestyle-Interventionen, weisen mHealth-Angebote mehrere potenzielle Vorteile auf. Dazu zählen vor allem der niedrighschwellige Zugang sowie die größere Reichweite, die durch die hohe Verbreitung von Smartphones ermöglicht wird (Puente & Martínez-Marcos, 2018).

Ähnlich wie klassische Lifestyle-Interventionen umfassen auch moderne und wirksame mHealth-Interventionen in der Regel psychoedukative und gesundheitsförderliche Inhalte, die mit kognitiv-behavioralen Elementen kombiniert werden. Beispiele hierfür sind Funktionen zur Selbstbeobachtung des eigenen Verhaltens, zum Selbstmanagement oder zur Unterstützung realistischer Zielsetzung (Puig et al., 2019; Wang et al., 2020). Aufgrund ihrer technischen Möglichkeiten bieten Apps zudem häufig Erinnerungsfunktionen sowie Feedback in Form von Kurznachrichten (Puig et al., 2019; Wang et al., 2020).

Die Befundlage zur langfristigen Effektivität von mHealth-Interventionen in der Behandlung von Übergewicht und Adipositas ist zum aktuellen Zeitpunkt jedoch inkonsistent und begrenzt (Wang et al., 2020). Bislang nachgewiesene Effekte auf den Gewichtsverlust fallen häufig gering aus und werden als nicht klinisch relevant eingestuft (Beleigoli et al., 2019; Chew et al., 2022). Angesichts der genannten Vorteile werden mHealth-Anwendungen dennoch als vielversprechender Ansatz betrachtet, auch wenn weiterhin Forschungsbedarf besteht, um spezifische Komponenten zu identifizieren, die als hilfreich für Nutzende wahrgenommen werden und zu nachhaltigen Effekten beitragen können (Beleigoli et al., 2019). Aus Sicht der Nutzenden scheint es dabei besonders wichtig zu sein, dass Anwendungen benutzerfreundlich und vertrauenswürdig, dynamisch und interaktiv sowie an persönliche Bedürfnisse anpassbar sind (Bergevi et al., 2022). Insbesondere hinsichtlich des letztgenannten Punktes der Individualisierbarkeit bieten mHealth-Ansätze gegenüber klassischen Lifestyle-Interventionen deutliche Vorteile, denn klassische Lifestyle-Interventionen verfolgen häufig lediglich standardisierte, sogenannte *One-fits-all*-Ansätze, die die individuellen Bedürfnisse kaum berücksichtigen können (Lv et al., 2017).

## 1.5 Berücksichtigung von Geschlechtsunterschieden

Globale Statistiken zeigen, dass Übergewicht bei Männern und Frauen etwa gleich häufig vorkommt (Frauen 38%, Männer 37%), während Adipositas bei Frauen (15%) häufiger auftritt als bei Männern (10%) (NCD Risk Factor Collaboration, 2016). Für Deutschland zeigen aktuelle Daten, dass Männer häufiger von Übergewicht betroffen sind als Frauen (Frauen: 46,6%, Männer: 60,5%; Übergewicht einschließlich Adipositas), während sich hinsichtlich der Prävalenz von Adipositas keine Geschlechtsunterschiede zeigen (jeweils 19%) (Schienkiewitz et al., 2022).

Geschlechterspezifische soziale und psychologische Faktoren beeinflussen die Entwicklung von Übergewicht und Adipositas und sind daher auch für deren Behandlung relevant (Cooper et al., 2021). Auch in Bezug auf die in dieser Arbeit zentralen Themen, Stigmatisierungserleben, Essverhalten und Therapie, sind ebenfalls Geschlechtsunterschiede bekannt. Frauen berichten im Vergleich zu Männern häufiger über gewichtsbezogene Stigmatisierung- und Diskriminierungserfahrungen und weisen zudem eine höhere Selbststigmatisierung auf (Boswell & White, 2015; Spahlholz et al., 2016). Darüber hinaus zeigen sich Unterschiede in der Wahrnehmung des eigenen Körpergewichts und im Diätverhalten. Während Frauen dazu tendieren, ihr Gewicht zu überschätzen, neigen Männer eher zu einer Unterschätzung (Lemon et al., 2009). Auch hinsichtlich verschiedener Essverhaltensweisen bestehen geschlechtsspezifische Unterschiede. So weisen Frauen häufig höhere Ausprägungen emotionalen Essens auf als Männer (Anversa et al., 2021). In Bezug auf die Therapieerreichbarkeit und Interventionsbereitschaft zeigt sich, dass Frauen häufiger Diätversuche unternehmen als Männer (Tsai et al., 2015). Männer sind hingegen insgesamt schwerer für Gewichtsreduktionsprogramme oder Lifestyle-Interventionen zu erreichen und nehmen seltener daran teil (Cooper et al., 2021). Entscheiden sie sich jedoch für eine Teilnahme, erzielen sie tendenziell größere Erfolge als Frauen (Kantowski et al., 2024).

## 2 Forschungsfragen und Studien

Die vorliegende Dissertation untersucht die Wirksamkeit einer psychologischen Intervention zur Veränderung dysfunktionalen Essverhaltens bei Personen mit Übergewicht und Adipositas. Der Fokus auf das Essverhalten ergibt sich aus der Erkenntnis, dass dysfunktionales Essverhalten maßgeblich zur Aufrechterhaltung von Übergewicht beiträgt, das wiederum mit vielfältigen körperlichen und psychischen Belastungen einhergehen kann (vgl. Kapitel 1.1 und 1.2).

Eine zentrale Herausforderung bestehender Interventionen bei Übergewicht und Adipositas besteht darin, langfristig stabile Verhaltensänderungen zu erreichen. Der in dieser Arbeit verfolgte Ansatz geht davon aus, dass eine langfristige Veränderung dysfunktionalen Essverhaltens nur durch eine gezielte Auseinandersetzung mit zugrunde liegenden psychologischen Prozessen erreichbar ist. Erst der Aufbau eines stabilen, funktionalen Essverhaltens schafft die Grundlage für eine dauerhafte Stabilisierung des Körpergewichts. Um dies zu ermöglichen, sollten Interventionen möglichst alltagsnah und niedrigschwellig gestaltet sein, sodass eine kontinuierliche Auseinandersetzung mit dem eigenen Essverhalten unterstützt wird. Zugleich müssen sie ausreichend flexibel sein, um den individuell unterschiedlichen psychologischen Ausgangsbedingungen und Bedürfnissen der Nutzenden gerecht zu werden. Unterschiedliche Essverhaltensweisen sowie die psychologischen als auch sozialen Faktoren, die diese beeinflussen, verdeutlichen die Notwendigkeit einer individualisierten Herangehensweise. Dazu zählt auch die Berücksichtigung belastender Kontextfaktoren wie das Erleben gewichtsbezogener Stigmatisierung, die für viele Betroffene eine relevante Rolle in der Entwicklung und Aufrechterhaltung dysfunktionalen Essverhaltens spielen.

Genau hier bieten mHealth-Ansätze entscheidende Vorteile: Sie sind aufgrund der alltäglichen Smartphone-Nutzung jederzeit verfügbar und ermöglichen durch ihre technischen Gestaltungsmöglichkeiten auch eine flexible, bedarfsorientierte Anpassung der Inhalte. Damit schaffen sie einen vielversprechenden Rahmen, um psychologische Veränderungsprozesse im Alltag wirksam zu unterstützen.

Aus diesen Überlegungen abgeleitet, ergibt sich die folgende **Hauptfragestellung der Dissertation**: Kann dysfunktionales Essverhalten durch eine psychologische mHealth-Intervention wirksam verändert werden?

Zur Beantwortung der Hauptfragestellung wurden drei Studien durchgeführt, die jeweils spezifische **Teilfragestellungen (F1–F3)** adressieren.

**F1:** Wie trägt gewichtsbezogene Stigmatisierung zu dysfunktionalem Essverhalten bei?

**F2:** Wie kann eine psychologische mHealth-Intervention entwickelt und gestaltet werden, um relevante, individuelle Problembereiche der Nutzenden zu adressieren?

**F3:** Wie wirksam ist die entwickelte mHealth-Intervention I-GENDO zur Veränderung dysfunktionalen Essverhaltens?

Abbildung 3 zeigt einen Überblick über die Hauptfragestellung, Teilfragestellungen und die jeweiligen Studien, welche zur Beantwortung dieser beitragen sollen.

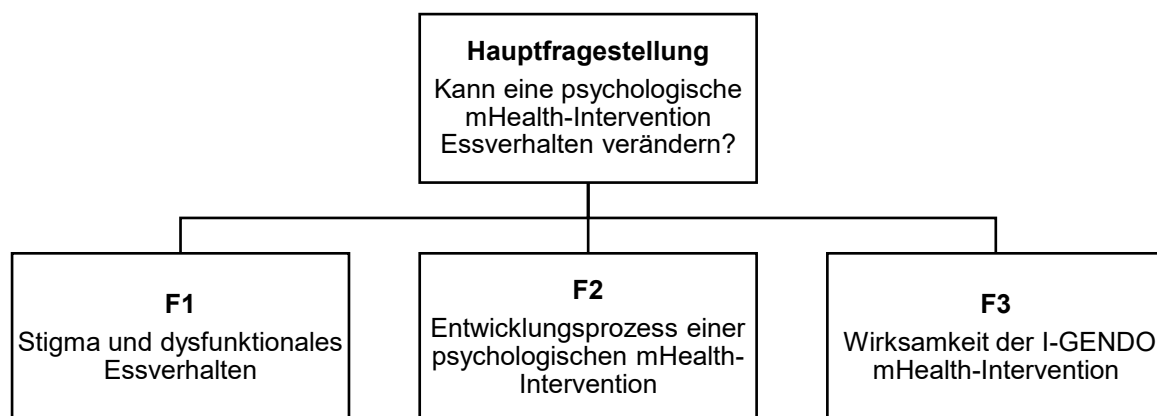


Abbildung 3. Hauptfragestellung und Teilfragestellungen (F1–F3) der Dissertation.

**Studie 1 (zu F1)** mit dem Titel *Weight bias internalization as a mediator between weight stigma and eating behavior: divergent patterns in individuals with normal weight and individuals with overweight* untersucht, wie gewichtsbezogene Stigmatisierungserfahrungen und deren Internalisierung mit emotionalem (dysfunktionalem) sowie restriktivem (funktionalem) Essverhalten zusammenhängen. Dabei werden Personen mit Übergewicht und Adipositas als auch Personen mit Normalgewicht einbezogen, um mögliche Unterschiede in den zugrunde liegenden Mechanismen aufzudecken. Die Ergebnisse sollen ein präziseres Verständnis der psychologischen Faktoren liefern, die funktionales und dysfunktionales Essverhalten beeinflussen und damit zur Entwicklung wirksamer Interventionen beitragen.

**Studie 2 (zu F2)** mit dem Titel *A tailored gender-sensitive mHealth weight loss intervention (I-GENDO): Development and Process Evaluation* untersucht, wie eine psychologische mHealth-Intervention entwickelt und gestaltet werden kann, um individuelle relevante psychologische Faktoren dysfunktionalen Essverhaltens gezielt anzusprechen. Die Studie beschreibt die Auswahl der Inhalte, die angestrebten psychologischen Zielkompetenzen sowie die Möglichkeiten zur Individualisierung, um auf unterschiedliche psychologische Bedürfnisse der Nutzenden einzugehen. Damit liefert Studie 2 die Grundlage für die Durchführung der Intervention und die spätere Evaluation ihrer Wirksamkeit.

**Studie 3 (zu F3)** mit dem Titel *Differential effects of the individualized gender-sensitive mHealth intervention I-GENDO on eating styles in individuals with overweight and obesity – a randomized controlled trial* untersucht die Wirksamkeit der entwickelten mHealth-Intervention in einer randomisierten kontrollierten Studie (RCT). Damit soll geprüft werden, inwieweit die Intervention dysfunktionales Essverhalten nicht nur kurzfristig, sondern auch langfristig verändern kann. Studie 3 liefert damit die zentrale Evidenz für die Beantwortung der Hauptfragestellung.

## 2.1 Studie 1: Weight bias internalization as a mediator between weight stigma and eating behavior: divergent patterns in individuals with normal weight and individuals with overweight and obesity

Die Studie zielt darauf ab, Zusammenhänge zwischen gewichtsbezogener Stigmatisierung und zwei Formen des Essverhaltens – emotionalem und restriktivem Essverhalten – sowohl bei Personen mit Übergewicht und Adipositas als auch bei Personen mit Normalgewicht zu untersuchen.

Wie in Kapitel 1.3 beschrieben, sind Personen mit Übergewicht und Adipositas häufig mit gewichtsbezogener Stigmatisierung konfrontiert (Prunty et al., 2020; Spahlholz et al., 2016). Es wird angenommen, dass Stigmatisierung auch zu dysfunktionalem Essverhalten wie emotionalem Essen beiträgt (Vartanian & Porter, 2016). In diesem Zusammenhang gilt die Ausprägung der Internalisierung von Stigmatisierung, also die Selbstzuschreibung des Stigmas, als besonders relevant, indem sie diesen Zusammenhang mediiert und somit die ungünstigen Effekte von Stigmatisierung auf emotionales Essverhalten erklärt (Pearl et al., 2020).

Interessanterweise ist gewichtsbezogene Stigmatisierung jedoch nicht auf Personen mit Übergewicht und Adipositas beschränkt. Auch Personen mit Normalgewicht (Prunty et al., 2020) erleben und internalisieren diese, wenngleich nicht so häufig wie Personen mit Übergewicht oder Adipositas (Pearl & Puhl, 2014). Wie bei Personen mit Übergewicht und Adipositas mediiert internalisiertes Stigma auch bei Personen mit Normalgewicht den positiven Zusammenhang zwischen Stigmatisierungserfahrungen und emotionalem Essverhalten (O'Brien et al., 2016). Das bedeutet, dass unabhängig vom tatsächlichen Körpergewicht, internalisierte Stigmata zu einer Verstärkung emotionalen Essverhaltens führen können.

Während emotionales Essverhalten überwiegend mit Gewichtszunahme korreliert (Koenders & van Strien, 2011; van Strien et al., 2012), gilt restriktives Essverhalten als potenziell schützender Faktor, der einer Gewichtszunahme entgegenwirken kann (Teixeira et al., 2010). Dieser protektive Effekt kann selbst dann bestehen, wenn gleichzeitig auch Essverhaltensweisen vorliegen, die typischerweise mit einer Gewichtszunahme in Verbindung stehen (van Strien et al., 2009). Es liegen jedoch bislang kaum empirische Befunde zu möglichen Zusammenhängen zwischen Stigmatisierung und restriktivem Essverhalten unter Berücksichtigung der Selbststigmatisierung vor, insbesondere mit Blick auf Unterschiede zwischen Personen mit Übergewicht und Adipositas sowie Personen mit Normalgewicht. Es bleibt daher weitgehend ungeklärt, ob und in welchem Ausmaß Stigmatisierungserleben nicht

nur zur Ausprägung emotionalen Essverhaltens beiträgt, sondern auch restriktives Essverhalten beeinflusst und ob Selbststigmatisierung hierbei ebenfalls eine mediierende Rolle einnimmt.

Zur Schließung dieser Forschungslücke untersucht Studie 1 den Beitrag gewichtsbezogener Stigmatisierung zu emotionalem und restriktivem Essverhalten in beiden Personengruppen. Es wird angenommen, dass sowohl bei Personen mit Übergewicht und Adipositas als auch bei Personen mit Normalgewicht ein positiver Zusammenhang zwischen gewichtsbezogenem Stigmatisierungserleben und emotionalem Essverhalten besteht, der durch Selbststigmatisierung mediert wird. Hinsichtlich restriktiven Essverhaltens wird erwartet, dass ausschließlich bei Personen mit Normalgewicht ein positiver Zusammenhang zwischen Stigmatisierungserleben und restriktivem Essverhalten besteht. Explorativ wird zudem untersucht, ob Selbststigmatisierung in diesem Zusammenhang ebenfalls eine mediierende Funktion aufweist.

Studie 1 ist nachfolgend eingefügt. Sie befindet sich zum Zeitpunkt der Einreichung dieser Dissertation im Status *submitted* bei dem Journal *Eating and Weight Disorders – Studies on Anorexia, Bulimia and Obesity*.

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## **TITLE PAGE**

### **Title**

Weight bias internalization as a mediator between weight stigma and eating behavior: divergent patterns in individuals with normal weight and individuals with overweight and obesity.

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## ABSTRACT

**Purpose:** Weight stigma experiences are particularly common among individuals with overweight (IOW) and are linked to negative psychological outcomes and maladaptive eating behaviors associated with weight gain. Understanding how stigma impacts eating behavior is therefore crucial. Weight bias internalization (WBI) is a key mechanism that may amplify these negative effects. Although research on WBI is growing, its role across weight groups and its associations with different forms of eating behavior remain unclear. This study examines whether WBI mediates the relationship between weight stigma experiences and two eating behaviors: emotional eating, usually associated with weight gain, and restrained eating, which may protect against it. Potential differences between IOW and individuals with normal weight (INW) are explored.

**Method:** A total of  $N = 332$  individuals, including  $n = 213$  IOW ( $M_{\text{BMI}} = 33.35$ ,  $SD_{\text{BMI}} = 3.79$ ) and  $n = 119$  INW ( $M_{\text{BMI}} = 22.08$ ,  $SD_{\text{BMI}} = 1.91$ ) completed an online survey. Self-reported data on weight stigma experiences, WBI, emotional eating and restrained eating were assessed. Mediation analyses were conducted separately for IOW and INW.

**Results:** WBI mediated the relationship between weight stigma experience and emotional eating in both IOW and INW. However, WBI only mediated the relationship between weight stigma and restrained eating in INW.

**Conclusion:** WBI plays a central role in how weight stigma affects eating behavior, with patterns differing by weight status. IOW may be more prone to emotional eating and less likely to engage in restrained eating, potentially reflecting the cumulative burden of chronic stigma exposure.

**Keywords:** weight stigma, weight bias internalization, eating behavior, overweight, normal weight

**Level of Evidence:** Level III, well-designed cross-sectional analysis.

## INTRODUCTION

According to World health Organization [1] body weight is classified in normal weight (BMI 18.5–24.9 kg/m<sup>2</sup>), overweight (BMI  $\geq$  25.0 kg/m<sup>2</sup>) and obesity (BMI  $\geq$  30.0 kg/m<sup>2</sup>). The prevalence of obesity has risen sharply in recent years and has even doubled between 1990 and 2022 [1]. Overweight and obesity is associated with various physical health issues, such as cardiovascular diseases [1], but also impacts psychological well-being [2]. The causes of overweight and obesity are multifaceted and complex [3] and influenced by several psychological, psychosocial and cognitive aspects [4].

Overweight and obesity are highly stigmatized in several domains, such as interpersonal relationships, workplace, or healthcare settings [5,6]. The stigma of obesity encompasses negative stereotypes, prejudiced attitudes and discriminatory behaviors directed toward individuals with higher body weight [5–7]. For instance, individuals with overweight (IOW) are more likely to be ascribed as lazy compared to individuals with normal weight (INW) [8]. Experiencing weight stigma is related to a range of negative mental health outcomes, including increased psychological distress, higher rates of depression and anxiety, reduced self-esteem, and greater body dissatisfaction [9–11]. It is also related to unfavorable behavioral aspects impeding weight loss, such as decreased motivation to exercise, social withdrawal [12], increased unhealthy or disordered eating behaviors, and reduced motivation to follow dietary recommendations [12–14]. There is the assumption that weight stigma can set off a vicious cycle of weight gain in obesity, in a way, that weight stigma experiences are leading to emotional distress, and a subsequent increase in maladaptive eating behaviors to cope with this stress, contributing to further weight gain [15]. One such maladaptive eating behavior is emotional eating, which describes eating in response to negative emotions [16]. Several studies have demonstrated a link between experiences of weight stigma and increased emotional eating [11]. Emotional eating has been found to be more prevalent in IOW than in INW [17], and is also associated with weight gain [18].

As eating behavior is an important contributor to the development of obesity [3], knowledge about mechanisms, that may help mitigate negative consequences of weight stigma on eating behavior is highly relevant. The negative effects of weight stigma on eating behavior and body weight are well studied [14]. But recent research findings suggest that experiencing weight stigma itself does not appear to be the primary cause of its effects on weight-related outcomes such eating behavior, but rather the internalization of the experienced weight stigma [19]. *Weight bias internalization* (WBI) describes that social stereotypes about overweight or obesity are accepted and attributed to oneself. The level of internalization reflects the degree to which a person believes that negative stereotypes or biases are true of him or herself [20]. WBI is related to several negative health related factors, including dysfunctional eating patterns such as emotional eating [21,22]. With regard to emotional eating, a study of O'Brien et al. [23] shows that WBI mediates the relationship between stigma experience and emotional eating. Notably, this mediation effect of WBI was observed not only in IOW, but also in INW, suggesting that the negative impact of stigma and WBI on eating behavior occurs independently of body weight. Indeed, INW can also experience weight related stigma and exhibit WBI [24].

Since emotional eating is associated with weight gain [18] the question arises, what other factors or behavior might protect INW, who have also experienced weight stigma from gaining weight. Some researchers emphasize the role of restrained eating as a potential protective factor in reducing the risk of developing overweight [25]. Restrained eating describes the intentional restriction of food intake due to concerns about body weight [16]. Weight management studies have shown that a reduction of emotional eating, along with an increase in restrained eating are predictors for weight loss success and long-term maintenance [26]. Interestingly, some findings suggest that the relationship between weight stigma and restrained eating differs between IOW and INW. For instance, Z. Wang et al. [27] found that weight stigma experiences predicted restrained eating in adolescents with normal weight, but not in those with overweight. Supporting this, an experimental study by Major et al. [28] demonstrated

that, after confrontation with weight stigma, INW consumed fewer high-calorie snacks and reported greater dietary self-efficacy compared to IOW.

Since the mediating role of WBI in the relationship between weight stigma experiences and emotional eating has already been demonstrated across different weight groups, it remains to be examined whether WBI might also mediate the relationship between weight stigma experiences and restrained eating and whether this effect differs between INW and IOW. Therefore, the present study investigates the associations of weight stigma experience, WBI, emotional eating, and restrained eating in both INW and IOW. Gender differences are also considered, given that previous research has shown that men and women differ in weight stigma experiences [6] and WBI [29].

## **METHOD**

### ***Sample and procedure***

Data for this secondary analysis came from the I-GENDO study. I-GENDO (Gender-sensitive enhancement of Common Weight Loss Strategies for Overweight and Obesity, ClinicalTrials.gov Identifier: NCT04080193) is a multicenter randomized controlled trial examining the effectiveness of an individualized, gender-sensitive smartphone intervention aimed at weight stabilization (for further details see Pape et al. [30]). Participants were recruited via internet, social media, and (with exception of the INW group) in the newspaper, radio or in obesity support groups from August 2019 until December 2020. Data collection was carried out using online questionnaires. All participants completed the same set of questionnaires, with slide wording adjustment made for INW (see Instruments). For inclusion in the study, IOW had to meet the following criteria: obesity class I or II (BMI 30.00–39.99), or overweight (BMI 25.00–29.99) in combination with weight-related physical or psychosocial problems. Additional inclusion criteria were owning a smartphone, sufficient German language skills, and current motivation to lose weight. INW were eligible if their BMI was within the range of 18.50 to 24.99. BMI was calculated based on self-reported weight and height. Exclusion criteria were

largely consistent across both weight groups and included current pregnancy, previous or planned bariatric surgery, intake of weight-influencing medication, serious or weight-influencing physical illnesses, and suspected alcohol dependence assessed by the AUDIT [31]. Further exclusion criteria were the presence of an eating disorder assessed through the Munich ED-Quest [32], or major depression, assessed through the PHQ-9 [33]. Furthermore, participants were excluded if they were currently undergoing psychotherapy related to weight issues or participating in a structured weight loss program with psychological components. In total,  $N = 332$  participants were included in the present analysis, comprising  $n = 213$  IOW ( $n = 143$  female,  $n = 70$  male) and  $n = 119$  INW ( $n = 84$  female;  $n = 35$  male). Sample characteristics are displayed in Table 1.

### ***Instruments***

To measure experiences of weight stigma, the *Perception of Teasing Scale* (POTS) [34], which assesses experiences with weight-related teasing as well as teasing regarding competencies, was used. For this study, only the six items specifically related to weight-related teasing were used – for example the item “People made fun of you because you were heavy”. Answers were given on a 5-point scale ranging from 1 (*never*) to 5 (*always*). For the analyses, mean values of these six item scores were calculated to represent the amount of weight stigma experiences. In addition, a dichotomous variable was created to indicate whether weight stigmatization had ever occurred. For the INW sample, item wording referring explicitly to “overweight” was adapted to be more weight-neutral, following the modifications described by O’Brien et al. [23]. For example, the item “People pointed at you because you were overweight” was adjusted to “People pointed at you because of your weight”.

To assess the degree of WBI, the *Weight Bias Internalization Scale* (WBIS) [20] was used. This scale measures the extent to which individuals have internalized weight-related stereotypes and prejudices. Participants responded to statements such as “Because of my weight, I don't understand how anyone attractive would want to date me” on a 7-point Likert

scale ranging from 1 (*strongly disagree*) to 7 (*strongly agree*). Following recommendations in the literature, the first of the 11 original items was removed in order to improve psychometric properties [35]. Sum scores of the remaining 10 items were calculated, with higher scores indicating a greater degree of WBI. For INW sample, items explicitly referring to "overweight" were modified in line with the adjustments proposed by Pearl & Puhl [36]. For example, the item "I hate myself for being overweight" was adjusted to "I hate myself for having this weight".

To assess eating behavior, the German version of the *Dutch Eating Behaviour Questionnaire (DEBQ)* [16,37] was used. The DEBQ consists of 30 items with three different subscales for eating styles: emotional eating (eating in response to emotional states such as anger or sadness), restrained eating (restriction of food intake due to concerns about weight), and external eating (eating in response to external cues, such as the sight or smell of delicious food). Participants rated their agreement with various statements, for example, "When I feel lonely, I would love to eat something" (emotional eating), on a 5-point scale ranging from 1 (*never*) to 5 (*very often*). For the present study, total scores were calculated for the emotional eating and restrained eating subscale. Higher scores indicate a stronger expression of the corresponding eating behavior.

### ***Statistics***

Statistical analyses were performed using SPSS 26 (IBM Corp, Armonk, NY, USA). For metric data, mean and standard deviation, for nominal scaled data frequencies and percentages were reported. Outliers were checked via boxplots and z-scores, normal distribution via P-P Plots and Shapiro-Wilk Test as well as through consideration of skew and kurtosis. In the case of violations, attempts were made to transform skewed variables, but as transformation of variables did not lead to fulfillment of assumptions, nonparametric or robust procedures were used for data analysis. Statistical significance was determined at the 0.05 level.

Differences in demographics between the two groups of IOW and INW were tested with Mann-Whitney-U-Tests for metric data and  $\chi^2$ -tests for nominal data. To investigate baseline group differences in metric variables of interest, several ANOVAs, taking gender into account, were calculated. For investigating group differences in dichotomous variables of interest  $\chi^2$ -tests were used. Before conducting mediation analyses, partial correlations between the variables of interest, controlling for age were performed separately for each BMI group. To examine whether WBI mediates the relationship between weight stigmatization experiences and eating behavior, simple mediation analyses were conducted. To explore potential differences between IOW and INW, the mediation analyses were performed separately for each BMI group. Weight stigma experiences were included as dichotomous predictor variable, indicating whether participants had ever experienced weight stigma (*yes/no*). The mediator variable WBI and the criterion variable eating behavior were used as metric variables. To examine potential moderation effects of gender, moderated mediation models were additionally computed. Age was included as a covariate in all models. All mediation and moderated mediation models were calculated using PROCESS [38] (CI = 95%; Analyses included a correction for heteroscedasticity [HC3 correction]; Bootstrapping 10.000; Bootstrapped confidence intervals for interpreting indirect effects; Effects are reported in unstandardized form).

## RESULTS

### *Participant characteristics*

Tables 1 and 2 present the means and standard deviations, or frequencies of occurrence, of demographics and variables of interest.

The group of IOW was older than INW ( $Mdn_{IOW} = 48.00$ ;  $Mdn_{INW} = 22.01$ ,  $U = 5378.00$ ,  $z = -8.702$ ,  $p < .001$ ), had a higher proportion of individuals being in a relationship ( $\chi^2(1) = 5.710$ ,  $p = .017$ ) and exhibited a higher educational level ( $\chi^2(1) = 6.14$ ,  $p = .013$ ). There were no significant differences in the gender ratio within the groups ( $\chi^2(1) = 0.421$ ,  $p = .517$ ).

Table 1. Demographics and BMI of IOW and INW

|                                             | IOW ( <i>n</i> = 213) | INW ( <i>n</i> = 119) | Total ( <i>N</i> = 332) |
|---------------------------------------------|-----------------------|-----------------------|-------------------------|
| BMI <i>M</i> ( <i>SD</i> )                  | 33.35 (3.79)          | 22.08 (1.91)          | 29.31 (6.31)            |
| age <i>M</i> ( <i>SD</i> )                  | 46.45 (12.13)         | 32.48 (12.64)         | 41.44 (14.01)           |
| gender <i>n</i> <sub>female</sub> (%)       | 143 (67.14)           | 84 (70.56)            | 227 (68.37)             |
| marital status <i>n</i> <sub>yes</sub> (%)* | 170 (79.8)            | 81 (68.1)             | 251 (75.6)              |
| education <i>n</i> <sub>uni</sub> (%)**     | 61 (28.6)             | 50 (42.0)             | 111 (33.4)              |

*Note.* IOW, Individuals with overweight or obesity. INW, Individuals with normalweight. BMI, body mass index. \*Marital status: currently living in a relationship yes/no. \*\*Education: highest educational degree (in this case: university). BMI, body mass index.

Two-way ANOVAS including BMI group and gender were conducted to examine differences in the variables of interest. In weight stigma experiences, a significant main effect of BMI group indicated that IOW reported a higher total amount of weight stigma experiences ( $F(1, 328) = 49.64, p < .001, \eta_p^2 = .131$ ). There was no significant main effect of gender or interaction effect between BMI group and gender (all  $p > .05$ ). For WBI a significant main effect BMI group and a significant main effect of gender was found, as well as a significant interaction between BMI group and gender ( $F(1, 328) = 7.32, p = .007, \eta_p^2 = .022$ ). Given this interaction, simple effects analyses were conducted. Results showed that WBI scores were higher in IOW compared to INW, both among women ( $F(1, 328) = 232.25, p < .001, \eta_p^2 = .415$ ) and men ( $F(1, 328) = 47.22, p < .001, \eta_p^2 = .126$ ). Within IOW, women reported significantly higher WBI scores than men ( $F(1, 328) = 28.19, p < .001, \eta_p^2 = .079$ ).

For emotional eating, a significant main effect of BMI group and a significant main effect of gender was found, as well as a significant interaction between the two factors ( $F(1, 328) = 5.53, p = .019, \eta_p^2 = .017$ ). Simple main effect analyses indicated that among women, IOW reported significantly higher emotional eating scores than INW ( $F(1,328) = 49.53, p < .001, \eta_p^2 = .131$ ). Additionally, IOW women had significantly higher scores than IOW men ( $F(1,328) = 30.88, p < .001, \eta_p^2 = .086$ ). No significant differences in emotional eating were observed between BMI groups among men, nor between genders within INW (all  $p > .05$ ). For

restrained eating, ANOVA revealed a significant main effect of BMI group ( $F(1, 328) = 10.08$ ,  $p = .002$ ,  $\eta_p^2 = .030$ ), indicating that IOW reported higher levels of restrained eating than INW. No significant main effect of gender or interaction between BMI group and gender was found (all  $p > .05$ ).

Table 2. Characteristics of IOW and INW

|                                                                   | IOW<br>total<br>( <i>n</i> = 213) | INW<br>total<br>( <i>n</i> = 119) | IOW<br>female<br>( <i>n</i> = 143) | IOW<br>male<br>( <i>n</i> = 70) | INW<br>female<br>( <i>n</i> = 84) | INW<br>male<br>( <i>n</i> = 35) |
|-------------------------------------------------------------------|-----------------------------------|-----------------------------------|------------------------------------|---------------------------------|-----------------------------------|---------------------------------|
| Experienced<br>stigma<br><i>n</i> <sub>yes</sub> (%) <sup>*</sup> | 182 (85.4)                        | 41 (34.5)                         | 125 (87.4)                         | 57 (81.4)                       | 30 (35.7)                         | 11 (31.4)                       |
| Total<br>stigma<br>experiences<br><i>M</i> ( <i>SD</i> )          | 1.80 (0.69)                       | 1.23 (0.5)                        | 1.87 (0.71)                        | 1.65 (0.65)                     | 1.24 (0.54)                       | 1.19 (0.39)                     |
| WBI<br><i>M</i> ( <i>SD</i> )                                     | 41.96 (12.67)                     | 20.92 (9.67)                      | 44.83 (11.61)                      | 36.11 (12.83)                   | 21.26 (9.43)                      | 20.11 (10.33)                   |
| Emotional<br>eating<br><i>M</i> ( <i>SD</i> )                     | 3.08 (0.99)                       | 2.37 (0.92)                       | 3.33 (0.91)                        | 2.58 (0.98)                     | 2.43 (0.94)                       | 2.22 (0.86)                     |
| Restrained<br>eating<br><i>M</i> ( <i>SD</i> )                    | 2.75 (0.58)                       | 2.45 (0.82)                       | 2.80 (0.56)                        | 2.64 (0.61)                     | 2.45 (0.88)                       | 2.46 (0.68)                     |

*Note.* IOW, individuals with overweight or obesity. INW, individuals with normal weight. WBI, weight bias internalization. <sup>\*</sup>Experienced stigma: life time weight stigma experience (yes/no).

### ***Correlations and mediation analyses***

Since IOW were older than INW, we first examined whether age was associated with any of the variables of interest. In IOW, age was negatively correlated to the amount of weight stigma experiences (Spearman's  $\rho = -.30$ ,  $p < .001$ ) and WBI (Spearman's  $\rho = -.27$ ,  $p < .001$ ). Therefore, age was included as a covariate in the subsequent analyses (see Table 3).

Table 3. Partial correlations, controlling for age between the variables of interest. INW (n = 119) are shown above the diagonal, IOW (n = 213) below the diagonal.

|                               | 1            | 2            | 3            | 4            |
|-------------------------------|--------------|--------------|--------------|--------------|
| 1 Total stigma experiences    | -            | <b>.31*</b>  | <b>.33**</b> | <b>.29*</b>  |
| 2 Weight bias internalization | <b>.40**</b> | -            | <b>.53**</b> | <b>.57**</b> |
| 3 Restrained eating           | .05          | .10          | -            | <b>.35**</b> |
| 4 Emotional eating            | <b>.21*</b>  | <b>.49**</b> | .04          | -            |

*Note.* IOW, individuals with overweight or obesity. INW, individuals with normal weight.

\* $p < .05$ , \*\*  $p < .001$ .

Controlling for age, in IOW as well as in INW, the total amount of stigma experiences positively correlated with WBI and with emotional eating. Likewise, in both BMI groups, higher WBI scores were associated with higher scores of emotional eating. However, only in INW, not in IOW, WBI was also positively associated with restrained eating. Moreover, a positive correlation between emotional eating and restrained eating was found exclusively in INW. Following the correlation analyses, simple mediation analyses were conducted to investigate whether WBI is responsible for effects of weight stigma experiences on eating behavior. For emotional eating mediation analyses were carried out in both BMI groups. For restrained eating, mediation analyses were carried out only in INW as in IOW restrained eating was not correlated to weight stigma experiences or WBI at all.

Table 4 shows the coefficients of all paths of the simple mediation models. We also conducted moderated mediation models, to test whether gender operates as a moderator in any model. As none of them showed a significant index of moderated mediation, the results of the moderated mediation models are not reported.

Table 4. Paths and coefficients of simple mediation models

| Table 4. Paths and coefficients of simple mediation models |   |       |             |      |        |        |                   |      |      |             |       |        |       |
|------------------------------------------------------------|---|-------|-------------|------|--------|--------|-------------------|------|------|-------------|-------|--------|-------|
|                                                            |   | B     | SE<br>(HC3) | p    | 95% CI |        |                   |      | B    | SE<br>(HC3) | p     | 95% CI |       |
|                                                            |   |       |             |      | Lower  | Upper  |                   |      |      |             |       | Lower  | Upper |
| IOW<br>(N = 213)                                           |   | WBI   |             |      |        |        | Emotional Eating  |      |      |             |       |        |       |
| Stigma                                                     | a | 7.165 | 2.577       | .006 | 2.085  | 12.245 | c'                | .079 | .191 | .679        | -.297 | .455   |       |
| WBI                                                        |   | -     | -           | -    |        |        | b                 | .039 | .005 | <.001       | .029  | .049   |       |
|                                                            |   |       |             |      |        |        | c                 | .357 | .200 | .075        | -.037 | .751   |       |
| INW (N = 119)                                              |   | WBI   |             |      |        |        | Emotional Eating  |      |      |             |       |        |       |
| Stigma                                                     | a | 6.400 | 1.870       | .001 | 2.697  | 10.104 | c'                | .295 | .167 | .080        | -.036 | .626   |       |
| WBI                                                        |   | -     | -           | -    |        |        | b                 | .050 | .009 | <.001       | .032  | .068   |       |
|                                                            |   |       |             |      |        |        | c                 | .613 | .177 | .001        | .262  | .965   |       |
|                                                            |   | WBI   |             |      |        |        | Restrained Eating |      |      |             |       |        |       |
| Stigma                                                     | a | 6.400 | 1.870       | .001 | 2.697  | 10.104 | c'                | .157 | .149 | .294        | -.139 | .453   |       |
| WBI                                                        |   | -     | -           | -    |        |        | b                 | .042 | .007 | <.001       | .028  | .056   |       |
|                                                            |   |       |             |      |        |        | c                 | .424 | .159 | .009        | .109  | .739   |       |

*Note.* IOW, individuals with overweight or obesity. INW, individuals with normal weight. Stigma, lifetime weight stigma experience (yes/no). WBI, weight bias internalization. All models were calculated with age as a covariate.

Simple mediation analyses showed that ever experienced weight stigmatization indirectly influenced emotional eating by its effect on WBI in both weight groups. As can be seen in Table 4 and Figure 1 individuals experienced weight stigmatization showed a higher degree of WBI (path a) than those never experienced weight stigmatization. Those with a higher degree of WBI had higher scores of emotional eating (path b). A bootstrap confidence interval for the indirect effect based on 10000 bootstrap samples was entirely above zero in both weight groups ( $ab_{IOW} = .278$ ,  $BootSE = .106$ ;  $BootCI = .079$  to  $.498$ ;  $ab_{INW} = .319$ ,  $BootSE = .121$ ,  $BootCI = .114$  to  $.586$ ). There was no evidence that experienced weight stigmatization influenced emotional eating independent of its effect on WBI (path c').

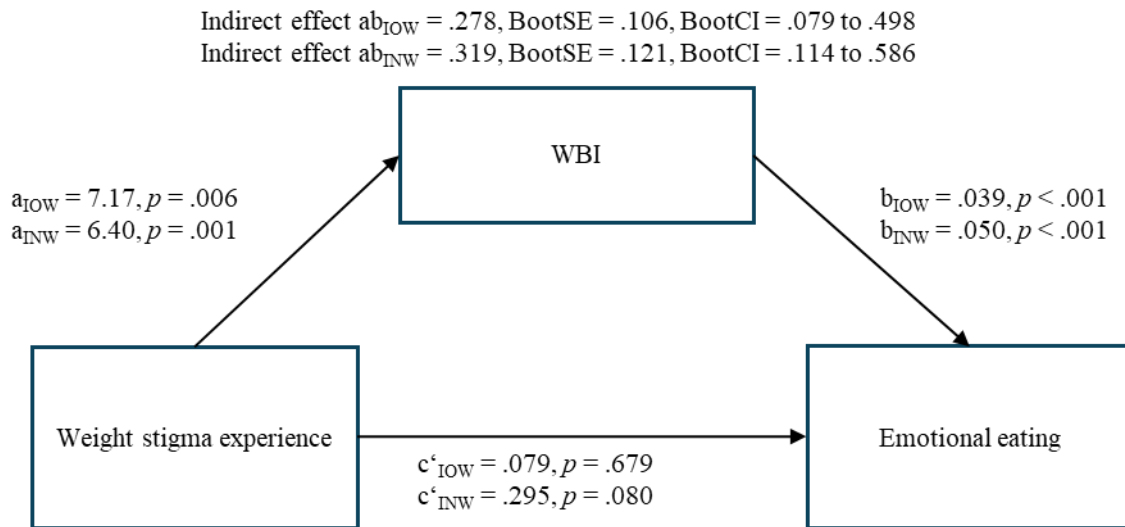


Figure 1. WBI as a mediator for emotional eating in IOW and INW.

For restrained eating, in INW, simple mediation analyses also showed that having experienced weight stigmatization indirectly influenced restrained eating by its effect on WBI (see Figure 2). In INW a higher degree of WBI was associated with higher scores of restrained eating (path b). In INW, the bootstrap confidence interval for the indirect effect based on 10000 bootstrap samples was entirely above zero ( $ab_{INW} = .267$ , BootSE = .089, BootCI = .111 to .459). There was no evidence that having experienced weight stigmatization influenced restrained eating independent of any effects on WBI in INW (path c').

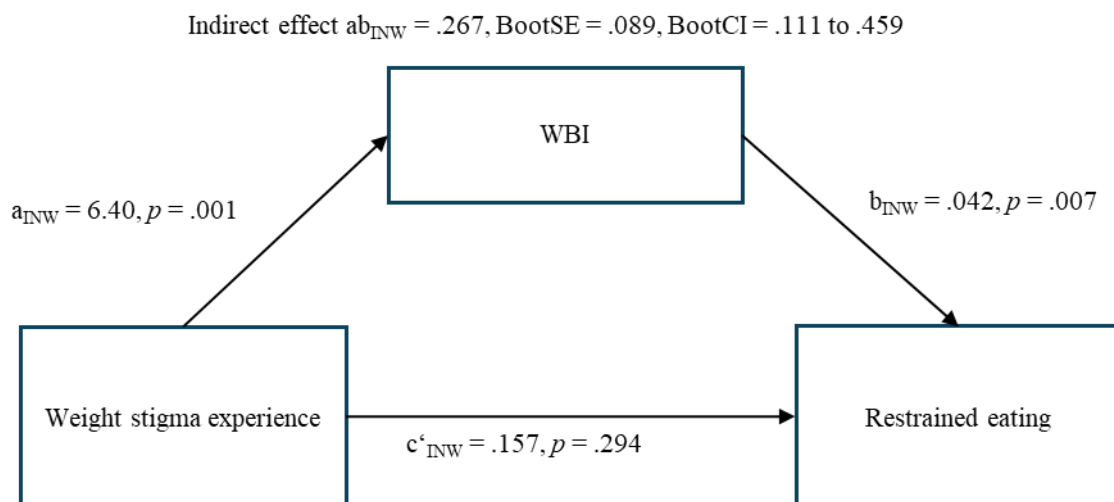


Figure 2. WBI as a mediator for restrained eating in INW.

## **DISCUSSION**

The study examined the role of WBI within the context of weight stigma experiences and their relationships with emotional eating and restrained eating among IOW and INW.

The results confirm that INW also experienced weight stigma, and that such experiences lead to WBI. Importantly, weight stigma experiences negatively affect emotional eating through WBI, regardless of body weight, thereby confirming findings from previous literature [23]. A novel finding of this study is that, among INW, WBI also contributes to restrained eating as a mediator. In contrast, no associations between weight stigma experiences, WBI and restrained eating were found among IOW.

### **WBI as a mediator for eating behavior**

In line with existing literature, INW also report experiences of weight stigma, although less frequently than IOW, and these experiences are associated with WBI [24]. While the role of WBI has received growing attention in recent years [21], only few studies have examined its mediating role in the relationship between weight stigma experiences and eating behavior. One exception is the study of O'Brien [23], which also found WBI as a mediator between weight stigma experiences and emotional eating, in both INW and IOW. Numerous other studies have also reported correlational associations between WBI and dysfunctional eating patterns, such as emotional eating, independent of BMI [21]. Emotional eating may thus represent a common coping mechanism for dealing with WBI across all weight groups [15,23,39].

Interestingly, we found that only in INW, WBI is responsible for both increased emotional and increased restrained eating in individuals who experienced weight stigma. This results in a balanced expression of these two eating behaviors, which were also significantly correlated with each other in INW. In contrast, among IOW emotional eating and restrained appear to be imbalanced. In IOW, WBI appears to primarily impact emotional eating without a corresponding increase in restrained eating.

It is well known that high emotional eating is a risk factor for weight gain, whereas restrained eating may prevent people from gaining weight [26]. Therefore, our results could mean that in INW weight gaining effects of emotional eating are compensated through restrained eating. In IOW the imbalance of high emotional but low restrained eating due to WBI could explain why they are more likely to develop overweight or continue gaining weight. To our knowledge, no prior study investigated WBI as a mediator between weight stigma experiences and restrained eating. However, our results are similar to those of some correlational and experimental studies. For example Z. Wang et al. [27] found that stigma experiences were associated with emotional eating in both adolescents with normal weight and with overweight, but with restrained eating on in those with normal weight. Similarly, in an experimental study, Major et al. [28] reported higher dietary self-efficacy after stigma exposure in adolescents with normal weight compared to those with overweight, emphasizing that perceived rather than actual weight status played a key role. In a later study, Major et al. [40] showed that stigma exposure reduced self-control and dietary control, especially among individuals concerned about being stigmatized, with greater effects in those with greater prior stigma experience.

These findings indicate that an increase in restrained eating following exposure to weight stigma is less commonly observed among IOW or those who anticipate being stigmatized. To understand this divergence, it is necessary to examine the underlying psychological and behavioral mechanisms. According to the model outlined by Tomiyama [15,39], weight stigma functions as a chronic stressor that triggers physiological and behavioral responses contributing to further weight gain and consequently to ongoing stigmatization. Specifically, weight stigma exposure elicits physiological stress responses such as increased cortisol levels, impairing cognitive functioning by reducing executive control and self-regulation [15,39]. These processes may be further intensified by the degrees of WBI [41]. Importantly, even in the absence of actual overweight or obesity, the mere anticipation or fear of being devalued due to one's weight can induce chronic stress and contribute to weight gain over time [42]. Although

weight stigma affects both INW and IOW, the latter are more frequently and persistently exposed to it [24]. This heightened exposure may partially explain the even higher risk of IOW for maladaptive behaviors such emotional eating [15,39] and may also contribute to a reduced cognitive capacity for restrained eating [43].

### **Gender**

We also conducted moderated mediation models, to examine whether gender influences the relationship between weight stigma experiences, WBI and eating behavior. No significant moderation effect of gender was found in any of the models. This result is somewhat unexpected, given that men and women in our sample differed in their levels of WBI and emotional eating. To draw more conclusions about potential gender differences in these processes, future studies with larger and more diverse samples may be necessary.

### **Strengths and limitations**

This study aimed to provide a deeper understanding of the role of WBI on eating behavior. Due to the cross-sectional study design, we cannot draw conclusions about past or future weight trajectories. However, we can assume that the extent of restrained and emotional eating plays a relevant role in weight development. Furthermore, we did not assess the self-perception of weight status, but only the actual weight. Future studies should address this limitation as previous research has shown that subjective weight perceptions rather than objective weight are associated negative self-attributions and behavioral outcomes [28].

This study demonstrated that weight stigma experiences and WBI are unrelated to restrained eating in IOW, whereas such associations, as well as a mediating effect WBI, are present in INW. Through our direct comparison of INW and IOW, better conclusions about the underlying mechanisms of eating behavior in response to weight stigma can be drawn than in studies focusing exclusively on IOW. Moreover, we screened for and excluded eating disorders in both IOW and INW, unlike previous studies that included or did not screen for Binge Eating Disorder

[23,44]. This is important, as eating behavior differs between IOW with and without Binge Eating Disorder [45].

## **CONCLUSION**

WBI plays a critical role in the development of maladaptive eating behavior following weight in individuals who have experienced weight stigma. Emotional eating appears to be a common response to weight stigma, independent of body weight. However, only in INW is a parallel increase in restrained eating also prevalent, resulting in a balanced relationship between emotional and restrained eating. In contrast, IOW typically exhibit high levels of emotional eating but comparatively low levels of restrained eating. This imbalance may reflect the greater frequency and chronicity of weight stigma experiences in this group. Although restrained eating may serve as a compensatory mechanism to counteract the weight-related consequences of emotional eating, its promotion as a coping strategy it is not without risks, as it may also increase the risk of other dysfunctional eating behaviors such as binge eating [46]. Therefore, interventions addressing eating behavior should also focus on the reduction of high levels of emotional eating. In conclusion, it is important to understand that maladaptive eating behavior occurs within a broader sociocultural context, in which persistent weight stigma plays a role and must be urgently addressed.

### **What is already known on this subject?**

Previous research has identified WBI as a relevant factor in the relationship between stigma experiences and emotional eating, with indications that this association is largely independent of BMI. However, it remains unclear whether WBI also plays a key role in the relationship between stigma experiences and other forms of eating behavior, and whether these mechanisms differ between IOW and INW.

### **What this study adds?**

This study demonstrates that WBI influences restrained eating differently in IOW and INW. These findings underscore the importance of addressing the consequences of WBI on eating

behavior within interventions, while also highlighting the need for public health strategies to reduce weight-related stigma.

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## **DECLARATIONS**

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### ***Competing interests***

The authors declare no competing interests.

### ***Author contributions***

TF, MP, CS, SSL, JW and SH designed the study. TF, CS, and MP collected the data for the sample of IOW. TF and TV collected the data for the sample of INW and TV adapted the instruments for INW. TF performed the data analysis, data interpretation, and generation of figures and tables. TF, MP, and JW drafted the manuscript. CS, TV, SSL, and SH contributed to the final version of the manuscript. All authors read and approved the final manuscript.

### ***Availability of data***

The datasets generated and analyzed during the current study are available from the corresponding author on reasonable request.

### ***Ethics approval***

The I-GENDO study was carried out in accordance with the Declaration of Helsinki. The Institutional Review Board of the Ruhr-University Bochum approved the study (Nr. 18-6415) as well as the ethics committee at the University of Bamberg approved this study.

### ***Consent to participate***

All participants were informed about the study and provided informed consent.

### ***Consent for publication***

Not applicable.

## ADDITIONAL FILE 1

**Journal:** Eating and Weight Disorders – Studies on Anorexia, Bulimia and Obesity

**Title:** Weight bias internalization as a mediator between weight stigma and eating behavior: divergent patterns in individuals with normal weight and individuals with overweight and obesity.

**Authors:** Färber, T., Pape, M., Seiferth, C., Vogel T., Steins-Loeber, S., Herpertz, S., & Wolstein, J.

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**Table A1** Two-way ANOVAS including BMI group and gender to examine differences in the variables of interest

|                          | ANOVA     |          |          |            |
|--------------------------|-----------|----------|----------|------------|
|                          | <i>df</i> | <i>F</i> | <i>p</i> | $\eta^2_p$ |
| <b>Stigma total</b>      |           |          |          |            |
| BMI group                | 1         | 49.637   | < .001   | .131       |
| gender                   | 1         | 3.180    | .075     | .010       |
| BMI group x gender       | 1         | 1.125    | .290     | .003       |
| <b>WBI</b>               |           |          |          |            |
| BMI group                | 1         | 200.358  | < .001   | .379       |
| gender                   | 1         | 12.441   | < .001   | .037       |
| BMI group x gender       | 1         | 7.322    | .007     | .022       |
| <b>Emotional eating</b>  |           |          |          |            |
| BMI group                | 1         | 29.539   | < .001   | .083       |
| gender                   | 1         | 17.412   | < .001   | .050       |
| BMI group x gender       | 1         | 5.527    | .019     | .017       |
| <b>Restrained eating</b> |           |          |          |            |
| BMI group                | 1         | 10.081   | .002     | .030       |
| gender                   | 1         | .842     | .360     | .003       |
| BMI group x gender       | 1         | 1.063    | .303     | .003       |

*Note.* BMI group, individuals with overweight compared to individuals with normal weight. Gender, male compared to female. WBI, weight bias internalization

## 2.2 Studie 2: A tailored gender-sensitive mHealth weight loss intervention (I-GENDO): development and process evaluation

Bei der Entwicklung der mHealth-App I-GENDO steht insbesondere die gezielte Ansprache psychologischer Faktoren dysfunktionalen Essverhaltens im Vordergrund. Dies basiert auf der Annahme, dass die Förderung psychologischer Kompetenzen, die mit dysfunktionalem Essverhalten assoziiert sind, entscheidend für eine langfristige Verhaltensänderung ist (Teixeira et al., 2015; Varkevisser et al., 2019). Ein wesentlicher Vorteil von mHealth-Interventionen liegt in ihrem niederschweligen Zugang, der eine breitere Reichweite ermöglicht als herkömmliche Interventionen und somit eine größere Zahl von Betroffenen erreicht (Puente & Martínez-Marcos, 2018). Darüber hinaus eröffnen die technischen Möglichkeiten digitaler Interventionen die flexible Bereitstellung individualisierter Inhalte, die gezielt an die Bedürfnisse und Präferenzen der Nutzenden angepasst werden können (Ryan et al., 2019). Eine Individualisierung, basierend auf psychologischen Ausgangsvariablen und persönlichen Präferenzen, soll dabei die Effektivität der Intervention steigern können (Dugas et al., 2020; Ryan et al., 2019).

Studie 2 untersucht, wie relevante psychologische Inhalte und Interventionselemente, die zur Veränderung dysfunktionalen Essverhaltens beitragen sollen, ausgewählt und in einer mHealth-App umgesetzt werden können. Dafür wird der Entwicklungsprozess der App I-GENDO, einschließlich der Konzeption, Auswahl und Implementierung der Inhalte und Funktionen, dargestellt. Die Wirksamkeit der App in Bezug auf Veränderungen im Essverhalten wird in Studie 3 untersucht.

Studie 2 ist nachfolgend eingefügt.

### Literaturnachweis:

Pape, M., **Färber, T.**, Seiferth, C., Roth, T., Schroeder, S., Wolstein, J., Herpertz, S., & Steins-Loeber, S. (2022). A tailored gender-sensitive mHealth weight loss intervention (I-GENDO): development and process evaluation. *JMIR Formative Research*, 6(10), e38480. <https://doi.org/10.2196/38480>

Original Paper

# A Tailored Gender-Sensitive mHealth Weight Loss Intervention (I-GENDO): Development and Process Evaluation

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## Abstract

**Background:** Given the increase in the prevalence of overweight and obesity worldwide, the number of digital weight loss interventions has also risen. However, these interventions often lack theoretical background and data on long-term effectiveness. The consideration of individual and gender differences in weight-related psychological parameters might enhance the efficacy and sustainability of mobile-based weight loss interventions.

**Objective:** This paper presented an introduction to and the process evaluation of a 12-week gender-sensitive mobile health (mHealth) weight loss intervention (I-GENDO) combining computer-based and self-tailoring features.

**Methods:** Between August 2020 and August 2021, individuals with overweight (BMI 25.0-29.9 kg/m<sup>2</sup>), those with obesity class I (BMI 30.0-34.9 kg/m<sup>2</sup>), and those with obesity class II (BMI 35.0-39.9 kg/m<sup>2</sup>) were recruited to the I-GENDO project, a multicenter study in Germany. The mHealth intervention aimed at targeting individual psychological factors associated with the development and persistence of overweight and obesity (eg, emotional eating) using computer-based tailoring. Moreover, the intervention took a gender-sensitive approach by implementing self-tailoring of gender-targeted module versions. The computer-based assignment of the main modules, self-selection of gender-targeted module versions, and use patterns were evaluated while considering gender. Moreover, gender differences in the usability assessment were analyzed.

**Results:** Data from the intervention arm of the study were processed. A total of 116 individuals with overweight and obesity (77/116, 66.4% women; age mean 47.28, SD 11.66 years; BMI mean 33.58, SD 3.79 kg/m<sup>2</sup>) were included in the analyses. Overall, the compliance (90/109, 82.6%) and satisfaction with the app (mean 86% approval) were high and comparable with those of other mobile weight loss interventions. The usability of the intervention was rated with 71% (5.0/7.0 points) satisfaction. More women obtained the main module that focused on emotion regulation skills. Most men and women selected women-targeted versions of the main modules. Women used the app more frequently and longer than men. However, women and men did not differ in the progress of use patterns throughout the intervention.

**Conclusions:** We developed a tailored gender-sensitive mHealth weight loss intervention. The usability of and engagement with the intervention were satisfactory, and the overall satisfaction with the intervention was also high. Gender differences must be considered in the evaluation of the effectiveness and sustainability of the intervention.

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**KEYWORDS**

mobile health; mHealth; eHealth; tailoring; gender; weight loss intervention; mobile phone

## Introduction

Within the last few decades, a vast number of digital health apps have been developed worldwide [1,2]. eHealth interventions (ie, mobile health [mHealth] interventions) are cost-effective and feasible in everyday life and represent a useful addition to analog health care services, not only in times of a worldwide pandemic [3]. In 2021, 87% of German adults and adolescents aged >14 years owned a smartphone, and 27% reported using mHealth interventions regularly [4]. The use of mHealth interventions requires an active and self-determined engagement of the user and therefore facilitates behavioral changes [5]. For example, mHealth lifestyle interventions show good efficacy in promoting healthy behaviors such as dietary intake and physical activity [6-10]. Therefore, they are promising tools that could promote behavioral change in participants wishing to reduce weight [11]. However, most available interventions to date demonstrate only short-term effects of behavioral change, whereas long-term effectiveness, especially regarding weight loss, has either not been investigated or not been demonstrated [12-14]. An explanation for the lack of effects is that most weight loss apps have not been developed from a scientific background and thus lack sufficient consideration of psychological evidence-based strategies [15], which are an important aspect of effective weight loss programs (WLPs) according to international guidelines [16,17]. Moreover, most weight loss apps have been developed on a *one-size-fits-all* approach, despite indications from prior studies that targeted (tailored) interventions are more effective [18-20].

The term “tailoring” refers to the customization of a feature of an intervention based on the individual characteristics of the participants [21]. The participants might customize an intervention based on their own preferences (self-tailoring), or they might receive individualized interventions in which the program tailors the content, usually based on algorithms (computer-based tailoring). In the latter case, tailoring can be based on data from 1 assessment (static tailoring) or adapted to different assessments within an intervention process (dynamic tailoring). Studies have indicated that participants feel more strongly addressed by individualized interventions, are more satisfied with them, and are subsequently more engaged in their use, which enhances the efficacy of the programs [6,11,19,22-25]. Various psychological aspects are involved in the development and maintenance of overweight and obesity, including the experience of weight-related stigmatization [26], maladaptive coping strategies [27], or dysfunctional eating behaviors [28]. Therefore, developing computer-based tailoring features that consider such psychological aspects might be a key element in the optimization of digital WLPs.

Gender differences in the development and treatment of obesity and overweight have also been investigated [29,30]. In Germany, more men (43.3%) develop overweight (BMI 25-29.9 kg/m<sup>2</sup>) compared with women (28.8%), but there are no gender differences in the prevalence of obesity (BMI >30.0 kg/m<sup>2</sup>), with increasing prevalence rates in the past decades among both genders [31,32]. Men with overweight and obesity are less likely to accurately perceive their weight and are less dissatisfied with their overweight status [29]. Moreover, gender differences in

physical activity, eating behavior, and weight-related psychological parameters have been reported. For example, women engage more often in problematic eating behaviors, such as emotional eating (EE) and craving of special foods than do men [33]. Women consistently report higher levels of perceived stress and engage more in emotion-focused coping, such as rumination, whereas men often use problem-focused or avoidant coping strategies [34,35]. On average, men are more physically active [36]. Some biological sex differences have been published; for instance, in males, fat depositions are often in the visceral depot, which increases their risk for cardiovascular disorders [37-39]. More women participate in WLPs, yet the participating men lose more absolute weight [40,41]. Results on the adherence to WLPs are heterogeneous, depending on the intervention type, among other factors [42-44]. On the basis of reviewed studies, investigating the effect of gender on overweight and obesity outcomes to improve the effectiveness of WLPs is an important research agenda. A recently published meta-analysis comparing the effects of gender-targeted and gender-neutral WLPs however revealed no differences in weight-related outcomes, although gender-targeted interventions were more effective in promoting activity and improving nutrition [45]. However, the included *gender-targeted* WLPs were offered either to male or to female participants based on sex. We support the idea that psychological interventions should be gender sensitive instead of gender dichotomous and assume an increase in the effectiveness of the intervention if it is gender sensitive [46]. Therefore, to avoid prejudiced gender-based distinctions between individuals with overweight and obesity, we recommend implementing gender-sensitive self-tailoring features.

Against this background, we aimed at developing a smartphone-based psychological and gender sensitive weight-loss intervention with computer-based and self-tailoring features. In the first part of this paper, we have described the development process of the app with particular focus on the tailoring features of the intervention. The subsequent process evaluation focuses on the evaluation of the app with regard to the psychological and gender-sensitive tailoring features, use patterns, and satisfaction with the app derived from a sample of 116 participants taking part in the I-GENDO project [47].

## Methods

### The I-GENDO Project

The project “Gender-sensitive enhancement of common weight-loss strategies for overweight and obesity: A personalized smartphone app” was proposed by the University of Bamberg, Departments of Clinical Psychology and Psychotherapy and Pathopsychology, in cooperation with LWL-University Hospital of Ruhr-University Bochum, Department of Psychosomatic Medicine and Psychotherapy, and funded by the Federal Ministry of Education and Research of Germany (01GL1719A/B). The project was preregistered (ClinicalTrials.gov identifier: NCT04080193).

### Ethical Considerations

This study was conducted in accordance with the Declaration of Helsinki. The Institutional Review Board of Ruhr-University

Bochum approved the study (number 18-6415). All participants were informed about the study and provided written informed consent.

### Development of the mHealth Intervention I-GENDO

From September 2017 to November 2019, a modular app system was developed at the University of Bamberg in cooperation with an external software provider (groupXS Solutions GmbH).

**Figure 1.** The I-GENDO app interface.

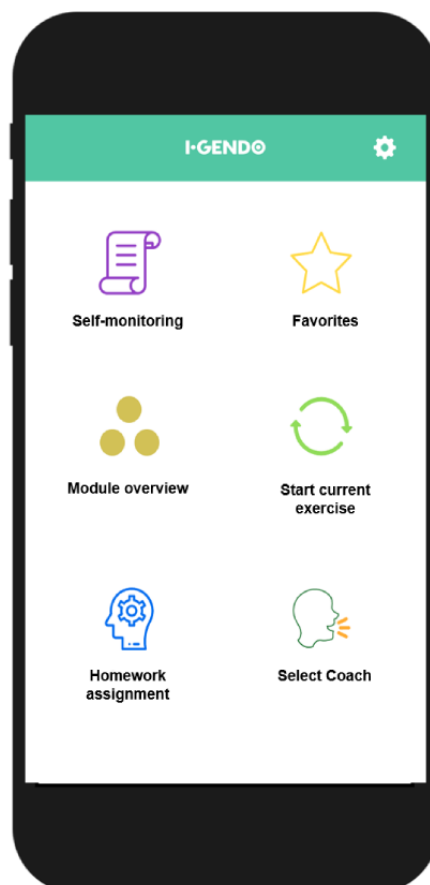


Figure 1 provides an overview of the I-GENDO app interface. The app provided the following elements: module-based psychological intervention; selection of an accompanying coach; and self-monitoring of hunger, appetite, and mood.

The content of the modules was based on the existing evidence-based manuals, qualitative data from focus groups of individuals with overweight and obesity, and interviews with experts in the field of psychological treatment of obesity. To implement a gender-sensitive approach, extensive literature reviews were conducted on the disparities between genders in the psychological and behavioral aspects of obesity treatment. Furthermore, a steering committee consisting of experts in the field of prevention and treatment of overweight and obesity, digital transformation, and qualitative data analyses was formed. All principal decisions regarding app development were made in consensus with the members of the steering committee.

On the basis of this information, 7 modules that served as the heart of the 12-week I-GENDO intervention were constructed. Of the 7 modules, 2 modules addressed the introduction to (goal setting) and conclusion (relapse prevention strategies) of the intervention. The remaining 5 modules (main modules) focused on different psychological parameters associated with the development and maintenance of overweight and obesity: stress management skills (*stress module*), emotion regulation skills

(*emotion module*), dealing with the consequences of overweight (*consequences module*), self-regulation skills (*control module*), and self-efficacy (*self-efficacy module*). Each module contained 9 sessions, which included psychoeducational elements delivered through texts and videos, several therapeutic tools from different therapeutic approaches (ie, cognitive behavioral therapy, dialectical behavioral therapy, and mindfulness), and various behavior change techniques [48]. These sessions could be repeated as many times as desired, and users could set a short link to their favorite exercises via the toolbox.

Each module was presented in either a women-targeted version (*version A*) or a men-targeted version (*version B*), which differed in terms of knowledge transfer, communication style, and prioritization of topics. For example, in the *stress module*, this was achieved using appealing case examples in the women-targeted version and fact presenting in the men-targeted version to transfer general knowledge about stress. Another example is that the men-targeted version in the *emotion module* highlighted and trained the recognition and labeling of emotions, whereas in the women-targeted version, the association between

dysfunctional beliefs and eating behavior was prioritized. [Multimedia Appendix 1](#) [48-77] provides an overview of the operationalization of the gender-sensitive modules and the origin of evidence. The versions were briefly introduced, with both introductions presented on 1 screen page. Participants could then freely choose between *version A* or *B* regardless of biological sex (gender-sensitive instead of gender dichotomous tailoring). Participants were blind to the manipulation of the gender-targeted versions.

## Process Evaluation of the mHealth Intervention I-GENDO

From December 2019 to December 2021, the effectiveness of the 12-week I-GENDO intervention was evaluated in a randomized controlled trial conducted at the University of Bamberg and LWL-University Hospital Bochum, Department of Psychosomatic Medicine and Psychotherapy (ClinicalTrials.gov Identifier: NCT04080193). The main results of the randomized controlled trial will be published elsewhere. In this manuscript, the relevant process evaluation data from the intervention arm were analyzed.

## Study Sample

Individuals were informed about the I-GENDO project via newspaper articles, radio features, and oral presentations at rehabilitation centers. Participants interested in the study were screened for eligibility ([Textbox 1](#)) and, if eligible, were invited to participate. According to the guidelines of the German Association for the Study of Obesity and the German Society for General and Visceral Surgery, individuals with obesity class III (BMI >39.9 kg/m<sup>2</sup>) experience a complex multifactorial framework of severe social, mental, and physical problems and are recommended to undergo bariatric surgery. Therefore, we excluded individuals with obesity class III from participation but provided further support. Because the effect of bariatric surgery on weight loss is mainly driven by physical limitations and varies significantly between the types of operative procedure [78], we decided to exclude individuals who underwent or planned to undergo bariatric surgery. The total study sample consisted of 213 individuals with overweight and obesity, of which 116 (n=77, 66.4% women) were randomly assigned to the intervention group for this study and subsequently included in this analysis.

**Textbox 1.** Eligibility criteria of the I-GENDO project.

### Inclusion criteria

- Legal age (≥18 years)
- Obesity class I or II with subjectively experienced weight-related impairment and a current intention to lose weight
- Overweight (ie, BMI between 25 and 29.9 kg/m<sup>2</sup>) with weight-related health problems, visceral adipose tissue, or high psychosocial weight-related distress and a current intention to lose weight

### Exclusion criteria

- Obesity class III (ie, BMI >39.9 kg/m<sup>2</sup>)
- Current (or within the last 12 months) involvement in a structured weight loss intervention
- Insulin-dependent type 1 diabetes
- Previous or intended bariatric surgery
- Current psychotherapeutic treatment of weight-related health problems
- Weight-enhancing drugs
- Drugs that promote weight loss (eg, antiobesity drugs)
- Weight-enhancing health problems that are not yet treated
- Cancerous disease within the last 5 years
- Current substance-use disorders, major depression, psychosis, suicidal tendency, or pregnancy
- Severe cognitive impairments
- Insufficient knowledge of the German language
- Binge-eating disorder or bulimia nervosa

## Intervention Phase

Participants in the intervention group received a 12-week tailored app intervention. In the first week of intervention, the introduction module was unlocked for each participant, followed by 9 weeks of tailored intervention comprising 3 of the 5 main modules. Each session of the 3 main modules was unlocked successively between weeks 2 and 9. The basic, minimal content of the remaining 2 modules was provided in the form of mini

modules, which were unlocked in week 11. Finally, the conclusion module was provided to each participant in week 12.

## Tailoring

[Figure 2](#) displays computer-based and self-tailoring features of the intervention. The introduction and conclusion module were mandatory elements framing the intervention that conveyed general content, whereas the main modules targeted individual

differences in weight-related psychological parameters. The main module assignment was computer-based and depended on the results of the Revised Illness Perception Questionnaire (IPQ-R), a standardized questionnaire adapted to overweight and obesity that measures illness beliefs (eg, “my overweight strongly affects the way others see me”) and causal attribution of overweight (eg, “my emotional state, e.g. feeling down, lonely, anxious, empty”) [79]. Participants completed the IPQ-R at the baseline assessment. Each of the 32 items were rated on a 5-point Likert scale ranging from 1 (“strongly disagree”) to 5 (“strongly agree”). In this study, the internal consistency of the scale was good (Cronbach  $\alpha=.714$ ). Scales were regenerated with higher means representing severe problems on the related psychological parameters associated with overweight and obesity (eg, EE). Of the 5 dimensions, 3 on which the

participants reported the highest impairments were tailored to the participants (computer-based tailoring). In addition to the computer-based tailoring feature, individual adaption of content and functions was enabled (self-tailoring). Each module was presented in either a men-specific (*version B*) or a women-specific version (*version A*; “App features” section and [Multimedia Appendix 1](#)). The app additionally contained customization features to enhance the adherence to the intervention [80]. In particular, the participants could choose between different coaches at the beginning of the 12-week intervention. A total of 4 different coaches were introduced: 2 men and 2 women coaches depicted as being either more friendly (eg, informal and motivating tips) or more professional (eg, formal and directive tips).

**Figure 2.** Tailoring features of the I-GENDO intervention. Of the 5 main modules (in the box), 3 were assigned to the participants based on the results of the revised illness perception questionnaire (computer-based tailoring). Each of the modules was presented in either a women- or men-targeted version (self-tailoring).



## Measurements

### Engagement With the App

Use patterns were retrieved from individual app data and subsequently analyzed. Actions were defined as time slots of active engagement with the app, for example, log-in to the app and processing a session (use frequency). Inactivity for 20 minutes defined the completion of one action. The overall app use time was calculated in minutes (use time). The participants who used the app at least 12 times (actions) and for 120 minutes within the 12-week intervention were defined as being compliant with the I-GENDO app.

### Satisfaction With the App

At the end of the conclusion module, the users could give feedback about their satisfaction with the app and the relevance and daily usefulness of the app on scales ranging from 0 (“not at all”) to 100 (“very much”). In the last session of each module, participants could evaluate how satisfied they were with the corresponding module.

### Usability Rating of the App

After the 12-week intervention, the mHealth App Usability Questionnaire for stand-alone mHealth apps used by patients was administered [81]. The original English questionnaire was translated into German by a member of the research group and retranslated by a native speaker. Deviations were discussed and subsequently adjusted. The self-report questionnaire consisted

of 18 items, which were scored on a scale from 1 (“strongly disagree”) to 7 (“strongly agree”), with higher means reflecting higher usability. Prior research indicated good psychometric properties of the English version of the mHealth App Usability Questionnaire [81]. In this study, the internal consistency of the total scale was excellent (Cronbach  $\alpha=.935$ ).

## Data Analysis

All analyses were conducted using SPSS for Windows (version 26.0; IBM Corp) and Excel (version 16.0; Microsoft Corp). App data were retrieved from Apache CouchDBTM. Descriptive analyses were conducted using percentages and frequencies for categorical variables and means and SDs for continuous variables. *Chi-square* distributions that compared categorical variables between genders were implemented, and Bonferroni-adjusted independent 2-tailed *t* tests were conducted to compare metrically scaled variables. Mann-Whitney *U* tests were conducted to compare results between genders on nonnormally-distributed variables. Friedman tests and Dunn-Bonferroni post hoc tests were implemented to compare app engagement between genders over the 12 weeks of intervention.

## Results

### Participants

We found no significant gender differences in age, BMI, marital status, and education level at baseline ([Table 1](#)).

Table 1. Sociodemographic factors (N=116).

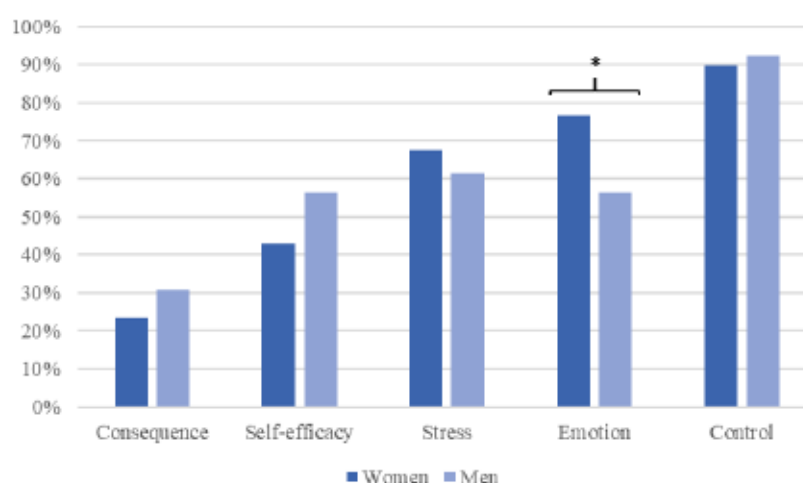
| Characteristic                             | Overall       | Women (n=77)  | Men (n=39)    | Women vs men         |                  |                      |
|--------------------------------------------|---------------|---------------|---------------|----------------------|------------------|----------------------|
|                                            |               |               |               | 2-tailed t test (df) | Chi-square (df)  | P value <sup>a</sup> |
| Age (years), mean (SD)                     | 47.28 (11.66) | 46.40 (12.22) | 49.00 (10.38) | 1.14 (114)           | N/A <sup>b</sup> | .26                  |
| BMI (kg/m <sup>2</sup> ), mean (SD)        | 33.58 (3.79)  | 33.75 (3.69)  | 33.23 (4.02)  | 0.70 (114)           | N/A              | .49                  |
| Marital status (yes), n (%) <sup>c</sup>   | 91 (78.4)     | 57 (74)       | 34 (87)       | N/A                  | 1.9 (1)          | .17                  |
| Education (university), n (%) <sup>d</sup> | 36 (31)       | 25 (32)       | 11 (28)       | N/A                  | 0.1 (1)          | .80                  |

<sup>a</sup>Bonferroni-adjusted P values.<sup>b</sup>N/A: not applicable.<sup>c</sup>Number of participants in a relationship.<sup>d</sup>Number of participants with a university degree.

### Tailoring

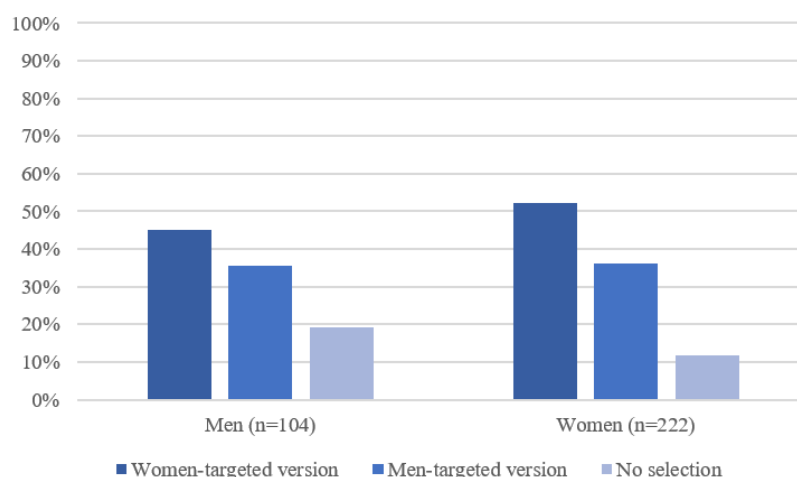
Three main modules were tailored to each of the 116 participants by computer-based tailoring according to their IPQ-R results (see the section *Tailoring*). Most participants (105/116, 90.5%) received the *control module*, followed by the *emotion module* (81/116, 69.8%), *stress module* (76/116, 65.5%), and *self-efficacy module* (55/116, 47.4%). One-quarter of the

participants (30/116, 25.9%) received the *consequence module*. Figure 3 illustrates the module assignments for the participating men and women separately. Significantly more women obtained the *emotion module* than men ( $\chi^2_1=4.1$ ;  $P=.04$ ;  $\phi=0.21$ ). The genders did not differ in the assignment of the *consequence* ( $\chi^2_1=0.4$ ;  $P=.53$ ), *self-efficacy* ( $\chi^2_1=1.6$ ;  $P=.23$ ), *stress* ( $\chi^2_1=0.2$ ;  $P=.66$ ), or *control module* ( $\chi^2_1=0.02$ ;  $P=.89$ ).

Figure 3. Assigned full-version modules (computer-based tailoring) in percentage (\* $P<.005$ ).

As described earlier, at the beginning of each module, the participants were instructed to choose between either a women-targeted or a men-targeted version (self-tailoring). In 50% (163/326) of the choices, the women-targeted versions were selected (women: 116/222, 52.3%; men: 47/104, 45.2%). In 35.9% (117/326) of the choices, the men-targeted versions

were selected (women: 80/222, 36%; men: 37/104, 35.6%). In the remaining 14.1% (46/326) of the choices, no selection was made (Figure 4). When the participants did choose a version, they chose version A 58.2% (163/280) of the time (women: 116/196, 59.2%; men: 47/84, 56%).

**Figure 4.** Module version assignments (self-tailoring) in percentage (total choices: N=326).

Another customization feature of the intervention was the selection of an accompanying coach when starting the app for the first time. Most women (35/74, 47%) chose a friendly woman coach, 19% (14/74) chose a professional man coach, 18% (13/74) chose a friendly man coach, and 16% (12/74) chose a professional woman coach. Coach assessment in men was more balanced, with 34% (12/35) choosing a friendly woman coach, 23% (8/35) choosing a friendly man or professional woman coach, and 20% (7/35) choosing a professional man coach. No significant gender differences were found in coach assessment ( $\chi^2_3=1.9$ ;  $P=.60$ ).

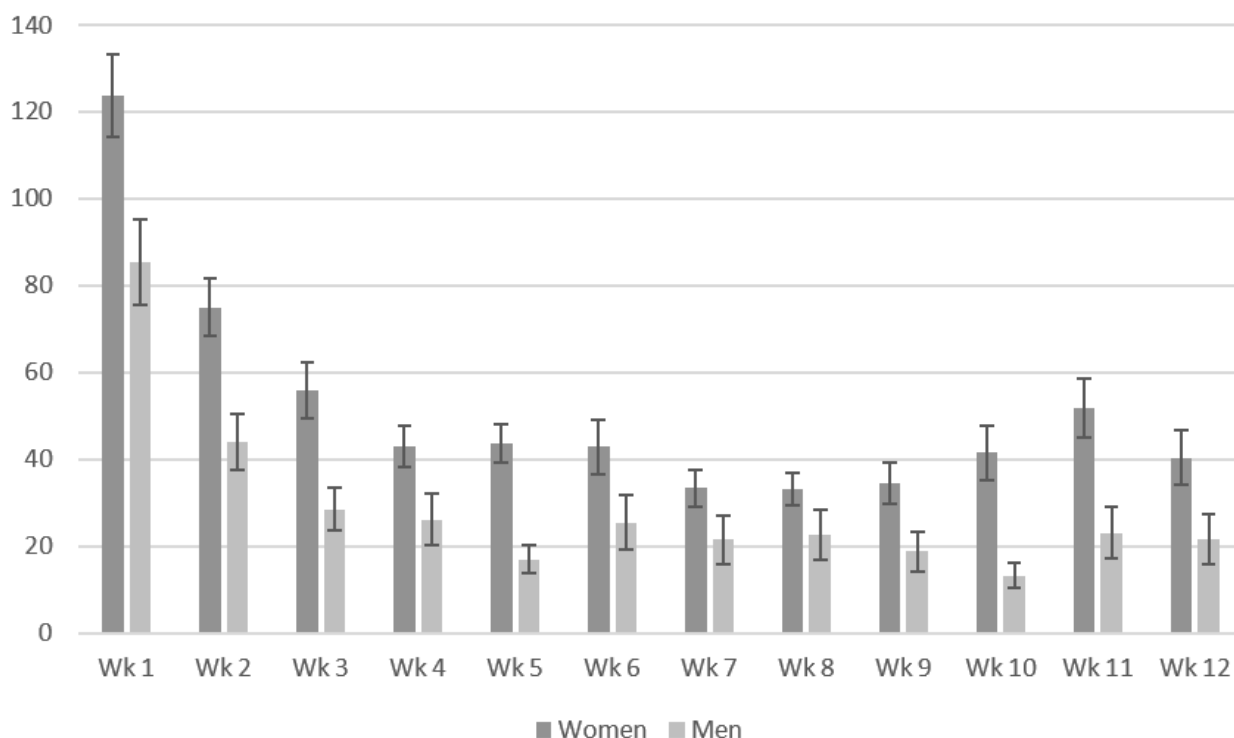
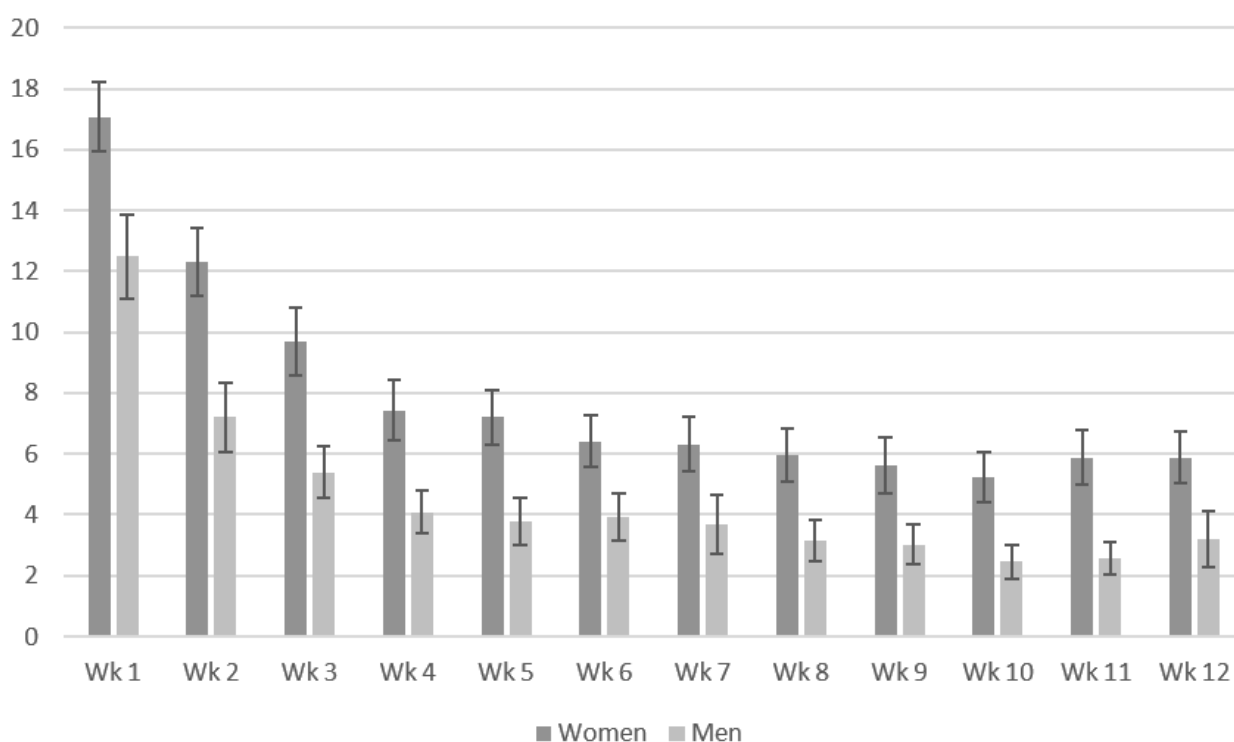
### Engagement With the App

Of the 116 participants in the intervention group, 109 actively participated in the app intervention phase. During the 12-week intervention period, the use frequency and use time were recorded.

We found significant gender difference in use frequency ( $U=908.00$ ;  $z$  score=-2.51;  $P=.01$ ;  $r=-0.24$ ) and use time ( $U=736.00$ ;  $z$  score=-3.63;  $P<.001$ ;  $r=-0.35$ ). The participating women used the app 97 (SD 88.03) times and for 625 (SD

427.94) minutes on average throughout the intervention, whereas the participating men used the app 56 (SD 45.62) times and for 347 (SD 285.68) minutes on average. In total, 82.6% (90/109) of the users were compliant with the app (women: 63/74, 85%; men: 27/35, 77%).

During the 12-week intervention phase, the use time ( $\chi^2_{11}=126.03$ ;  $P<.001$ ) and use frequency ( $\chi^2_{11}=139.51$ ;  $P<.001$ ) of the participating men ( $n=35$ ) decreased (Figures 5 and 6). The use time, ( $\chi^2_{11}=231.34$ ;  $P<.001$ ) and use frequency ( $\chi^2_{11}=309.16$ ;  $P<.001$ ) of the participating women ( $n=74$ ) also decreased. Dunn-Bonferroni post hoc tests revealed a significant decrease in use time within the first 3 weeks of intervention ( $z$  score=3.99;  $P<.001$ ;  $r=0.46$ ). From week 3 to week 12, use time and frequency leveled off at approximately 6.56 (SD 7.21) actions per week and 41.99 (SD 34.03) minutes per week for the participating women and 3.53 actions per week (SD 3.36) and 21.75 minutes per week (SD 21.88) for the participating men. We found no gender differences in use time progress ( $U=1075.00$ ;  $z$  score=-1.43;  $P=.15$ ) and use frequency progress ( $U=1106.00$ ,  $z$  score=-1.23;  $P=.22$ ) during the 12-week intervention period.

**Figure 5.** Use time per week in minutes (means and SEs of means).**Figure 6.** Use frequency per week in actions (means and SEs of means).

### Evaluation of the App

After completion, 41 participants evaluated the I-GENDO app. On average, the overall satisfaction with the app was high (mean 85.54, SD 19.36). In addition, the relevance of the content (mean 83.34, SD 20.03) and daily life usefulness (mean 78.95, SD

22.24) were evaluated as satisfactory. Of the main modules, the *stress module* (n=36) was rated best (mean 82.92, SD 14.05), followed by the *emotion module* (n=50; mean 81.66, SD 16.45), the *control module* (n=60; mean 80.47, SD 18.08), the *self-efficacy module* (n=29; mean 78.48, SD 17.66), and finally the *consequence module* (n=16; mean 67.75, SD 21.68).

In addition to the evaluation, the usability of the app was assessed using a standardized questionnaire (see the section *Usability Rating of the App*). The usability of the app was rated, on average, with 71% satisfaction (mean 5.00, SD 1.08 points; maximum: 7.00 points). No gender differences could be found between the usability ratings of men (mean 4.72, SD 1.07) and women (mean 5.13, SD 1.07;  $t_{99}=-1.76$ ;  $P=.08$ ).

## Discussion

### Overview

We aimed to introduce the I-GENDO app, a tailored gender-sensitive mHealth weight loss intervention, and present results from its process evaluation data. Therefore, data from the intervention arm of the I-GENDO project were analyzed. The sample included 116 ( $n=77$ , 66.4% women) individuals with overweight and obesity.

### Principal Findings

We developed a module-based 12-week intervention combining computer-based and self-tailoring features. Most participants (105/116, 90.5%) received the *control module*, which focused on self-regulation skills of food craving. The *stress module* was assigned to 65.5% (76/116) of the participants, and the *self-efficacy module* to 47.4% (55/116). The *consequence module* was obtained by 25.9% (30/116) of the participants. Significantly more women (59/77, 77%) than men (22/39, 56%) received the *emotion module*. Another tool of the intervention was the implementation of gender-sensitive self-tailoring features. We developed women- and men-targeted versions of the main modules. At the beginning of each module, participants could choose between the 2 versions. Among the participants who chose a version, *version A* was chosen 58.2% (163/280) of the time (women: 116/196, 59.2%; men: 47/84, 56%), which means that among both genders, the women-targeted module versions were predominantly selected.

In total, 82.6% (90/109) of the participants (women: 63/74, 85%; men: 27/35, 77%) were compliant with the I-GENDO app during the intervention phase. Use time and frequency significantly decreased during the 12-week intervention phase for both genders. After the first 3 weeks of intervention, use time leveled off and remained stable at approximately 42 minutes per week for the participating women and 22 minutes per week for the participating men. Similarly, use frequencies were approximately stable as of week 3 for both genders. Compared with the women, the men used the app infrequently and spent less time with the app. Nevertheless, the average use times and frequencies in both genders were satisfactory even in the last weeks.

The overall satisfaction with the app was high, with almost 86% (86/100) approval. In addition, the daily life usefulness and relevance of the content were ranked satisfactory by 79% (79/100) and 83% (83/100) of participants, respectively. The highest-rated main module was the *stress module* (83/100, 83%), but even the satisfaction with the *consequence module* was acceptable (68/100, 68%). In general, the usability ratings indicated that the I-GENDO intervention was good, averaging 5.0 out of 7.0 points (71%).

### Comparison With Prior Work

The heterogeneous computer-based administration of the main modules supports the tailoring feature. The *control module* was assigned to most participants. This is in line with the observation that decreased food-related inhibitory control is regularly associated with overweight and obesity [49,82,83]. Gender differences were found in the computer-based assignments of the *emotion module*, which significantly more women obtained. The module focused on dysfunctional emotion regulation and associations between negative emotions and (eating) behavior. EE refers to problems in the distinction between physiological appetite and eating as a strategy to cope with negative feelings [84]. EE is correlated with higher weight, severe depression symptoms, and the consumption of sweet energy-dense foods [85]. More women report negative emotions as causes for their overweight and engage more often in EE compared with men [50,85,86]. EE is associated with less intuitive eating by women, which could be a barrier to the implementation of healthy eating behaviors [87]. Studies indicate that more women undergo weight loss treatment, whereas participating men lose more absolute weight [29]. Focusing more on EE in treatment might contribute to a close in this gap. In addition, previous studies indicated that a relevant subgroup of individuals with overweight and obesity exhibit addiction-like eating behavior (ie, food addiction [FA]), characterized by an impaired food-related inhibitory control, EE, and food craving [88,89]. The prevalence of FA is higher in women than in men and is among other factors associated with higher BMI, dysfunctional eating behavior, and psychological distress [90,91]. Some studies reported lower adherence to and decreased effectiveness of WLPs in individuals experiencing FA, whereas others found no influence of FA on the success of WLPs [92-95]. As the *control* and *emotion* modules implement the treatment of dysfunctional EE behavior and exercises to improve food-related inhibitory control, participants experiencing FA might especially benefit from the intervention. Thus, the association between FA and the effectiveness of our intervention should be further investigated.

One-quarter of the participants received the *consequences module*, which focused on weight-related discrimination and the improvement of self-esteem and body image, as well as the social competences to deal with discrimination. The extent of this use might explain the prevalence of weight discrimination being higher in our sample than in the results of a representative German study reporting prevalence rates ranging from 5.6% to 18.7% in individuals with overweight and obesity (classes I and II) [96]. We hypothesized that individuals who have experienced discrimination might prefer seeking WLPs based on psychological rather than lifestyle features. Moreover, in our study, the *consequence module* was assigned to more men (12/39, 31%) than women (18/77, 23%), which appears to be in contrast to the results of the previously cited study that reported double the prevalence of weight-based discrimination in women [96]. The anonymity of a smartphone-based intervention combined with the opportunity to receive specialized psychological support targeted to individual needs could have been particularly appealing for men who had experienced weight-related discrimination and were affected by the consequences of their overweight. Nevertheless, the

module generally focused on weight-related emotional and physical consequences, which might be appealing to individuals with overweight and obesity regardless of whether they experienced discrimination.

Gender differences in health care services are an important consideration for the improvement of treatment outcomes [97]. Prior studies have indicated gender differences in eating behavior, as well as the psychological factors associated with weight gain and maintenance, highlighting the need for gender-targeted weight loss interventions [29,40]. As the effectiveness of gender dichotomous tailoring does not significantly differ from that of gender-neutral interventions [45], we implemented gender-sensitive self-tailoring features. The participants could choose between 2 gender-targeted versions at the beginning of the modules. The selection of the versions was heterogeneous, with most participants choosing women-targeted versions. This result supports the idea of gender-sensitive interventions to overcome gender binary [46]. However, its influence on the effectiveness of the intervention needs to be further investigated.

In complex digital interventions, the consideration of relevant process evaluation data (eg, usability testing and use patterns) is crucial before interpreting the effectiveness of the intervention [98]. The compliance with the app was satisfactory (90/109, 82.6%) and comparable with other studies. Signal et al [99] developed an eHealth intervention for prediabetes and diabetes self-management. They reported that 74% of the participants were actively engaged (ie, any use data were detected at any time throughout the 16-week intervention). Ruf et al [100] developed an mHealth intervention that assesses event-contingent dietary intake and physical activity, as well as relevant psychological parameters. Compliance, defined as the percentage of complete prompts within the total number of prompts received, was 80%. Another mHealth intervention focused on the management of food-related impulses to facilitate weight loss [101]. In that study, the completion rate (the number of participants who provided data at the 3-month follow-up) was 76%. These findings suggest that our compliance rate is comparable or even higher, although the differences in operational definitions cloud the interpretation.

Throughout the intervention, the use time and frequency decreased in both genders. Decreases in engagement were also reported in other studies; that is, in those with extended intervention periods [99,102]. Reductions in engagement and high dropouts are typical for internet-based interventions and are caused by a variety of reasons [103]. We hypothesized that the reduction in engagement observed in our study might be associated with the high number of competing commercial digital weight loss interventions, which might be less demanding, compared with psychological interventions. Moreover, the intervention phase of our study fell within the first and second lockdowns of the COVID-19 pandemic in Germany in 2020. During this period, the level of psychological distress increased, and vulnerable people engaged more often in dysfunctional eating patterns (ie, EE) [104]. In addition, many people were affected by short-term work or job losses and subsequent income losses [105]. It is likely that people neglected the intervention during this burdensome period.

The results from previous studies on the adherence to mHealth interventions are heterogeneous, with some reporting higher engagement in men [29,40,106] and others reporting higher engagement in women [99]. In our study, women used the app more frequently and spent more time on it. In the general German population, women report higher smartphone use time (mean 167 min/day) than men (mean 154 min/day), which might at least partially explain these differences [107]. Moreover, women are more interested in body appearance and health-related topics than men and use the internet more frequently for medical and health research [108-110]. Studies have also reported that women are more likely to use mHealth interventions focusing on nutrition and self-care apps, whereas men are more likely to use fitness apps [111-113]. Therefore, the lower engagement of the participating men in this study might be because the app focused on psychological rather than physiological determinants of overweight and obesity.

As reported in a recently published systematic review [114], other studies on mHealth interventions have either failed to report gender differences in the adherence to and usability of these interventions or reported results from biased samples with approximately 90% of women [115-117]. Given that higher engagement in mHealth interventions is usually associated with better outcomes [22,24,118], we propose that the samples in future studies should be more balanced with regard to gender and implement gender-sensitive feasibility and usability testing. Overall, the compliance with the app (90/109, 82.6%) and satisfaction with the app (86/100, 86%) were high and comparable with those of other mHealth interventions [99-101,119]. The usability of the app was rated with 71% (5.0/7.0 points) satisfaction. Other evidence-based mHealth weight loss interventions reported comparable or even lower usability scores, between 61.9% and 69.3% [100,119]. In addition, Ferrara et al [120] reviewed the usability of commercial weight loss apps, which can be downloaded from Google Play and the Apple Store. Scientists ranked the usability of these apps between 47% and 89%.

## Limitations

In our study, men and women differed in the assignment of main modules, which focused on psychological parameters associated with the development and maintenance of overweight and obesity. Interestingly, most men and women selected the women-targeted versions of the main modules. Given that the participants were blind to the gender-targeted manipulation, we suggest that the selections were not influenced by social desirability. Future studies should distinguish between gender differences based on the results from explicit and implicit assessments to adjust for social norms. Moreover, the participants were forced to select one version at the beginning of each module and were not allowed to switch versions. A reasonable approach could be to allow participants to test both versions to enhance their adherence to the app. In addition, it should be verified whether the introductions of the versions sufficiently hint at different module content.

It should be noted that only few participants (41/109, 37.6%) evaluated the app after completion. The evaluation was voluntary and was assessed at the end of the last session of the

intervention. Therefore, results regarding satisfaction with the app and the main modules should be interpreted cautiously.

The results from the process evaluation revealed that men and women differed in their app use. Women used the app more frequently and longer than men. Most of the scientists involved in the development process were women. Therefore, the women-targeted features of the app might have been more salient and thus confounded the selection by both genders. This methodological aspect might subsequently explain the higher use patterns of the participating women. Future studies or revisions of the app intervention should involve men scientists.

## Conclusions

In summary, given the high diversity in module assignment, we hypothesize that tailoring was successfully implemented in the intervention. The heterogeneous selection of the gender-targeted features might underscore the need for gender-sensitive (self-tailoring and blind choice) instead of gender dichotomous (computer-based tailoring) targeting but could also hint at methodological limitations, which need to be considered and further investigated in future studies. Further studies need to clarify whether the reported gender differences in the use and evaluation of the app confound the effectiveness and sustainability of the I-GENDO intervention.

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## Authors' Contributions

MP was involved in conceptualization, the acquisition of data, formal analysis, the interpretation of data, and the writing of the original draft. TF was involved in the acquisition and interpretation of data, review, and editing. CS and TR were involved in the acquisition of data, review, and editing. SS contributed to the study design. JW and SH contributed to the study design, supervision, review, and editing. SS-L contributed to the study design, conceptualization, study supervision, review, and editing.

## Conflicts of Interest

None declared.

## Multimedia Appendix 1

Evidence, content, and adaptations of the gender-sensitive main modules.

[\[DOCX File, 55 KB-Multimedia Appendix 1\]](#)

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## Abbreviations

**EE:** emotional eating  
**FA:** food addiction  
**IPQ-R:** revised illness perception questionnaire  
**mHealth:** mobile health  
**WLP:** weight loss program

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**Anhang zu Fachartikel 2:** Pape, M., Färber, T., Seifert, C., Roth, T., Schroeder, S., Wolstein, J., Herpertz, S., & Steins-Loeber, S. (2022). A tailored gender-sensitive mHealth weight loss intervention (I-GENDO): development and process evaluation. *JMIR Formative Research*, 6(10), e38480. <https://doi.org/10.2196/38480>

Supplementary Material 1: Evidence, content and adaptations of the gender-sensitive main modules

| Evidence [origin]                                                                                                                                                                                                                                                                                                                                                                                                                                      | Module               | Module Content                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                | Behavior Change Techniques[1]                                                                                                                             | Gender-Specific Adaptations                                                                                                                                                                                                                                                |
|--------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|----------------------|-----------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|-----------------------------------------------------------------------------------------------------------------------------------------------------------|----------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| <ul style="list-style-type: none"> <li>– Association between chronic stress (high levels of glucocorticoids) and unfavourable eating styles, negative affect and body weight [2]</li> <li>– Stress is a risk factor for obesity [3]</li> <li>– Women and men with obesity report more stressful life events than normal weight individuals [4]</li> <li>– Assumption that men with obesity tend to prefer individual, self-guided programs,</li> </ul> | <i>Stress Module</i> | <ul style="list-style-type: none"> <li>- psychoeducation: general information about stress development, responses and management</li> <li>- exercises to identify individual stress and stress responses and (dys)functional coping behavior</li> <li>- exercises to identify associations between stress and individual eating behavior, weight gain and well-being [8], [9]</li> <li>- exercises to improve personal stress management and coping skills based on the stress management training of Gerd Kaluza (i.e., time management, mindfulness, problem solving)[10], [11].</li> </ul> | Self-monitoring of behavior<br>Social support (emotional)<br>Behavior substitution<br>Behavioral rehearsal/practice<br>Action planning<br>Problem solving | <b>Version A:</b> <ul style="list-style-type: none"> <li>- psychoeducation based on relatable case examples</li> </ul> <b>Version B:</b> <ul style="list-style-type: none"> <li>- psychoeducation based on relatable gender-specific statistics, facts and data</li> </ul> |

|                                                                                                                                                                                                                                                                                                                                                                                          |                              |                                                                                                                                                                                                                                                                                                                                                                                                                                                       |                                                                                                                                                                                                 |                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                 |
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| <p>which focus on facts rather than “feelings”, prefer factual information on how to lose weight, men tend to prefer technical information and becoming an expert of their condition [5]–[7]</p>                                                                                                                                                                                         |                              |                                                                                                                                                                                                                                                                                                                                                                                                                                                       |                                                                                                                                                                                                 |                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                 |
| <ul style="list-style-type: none"> <li>– Association between emotional eating and weight gain [12]</li> <li>– Women with obesity report a high burden by emotional states [focus groups]*</li> <li>– Gender differences in emotional competences, emotional eating, usage of emotion-regulation strategies, women tend to engage in rumination more often than men [13], [14]</li> </ul> | <p><i>Emotion Module</i></p> | <ul style="list-style-type: none"> <li>- psychoeducation: general information about emotions and development of emotions (emergence of emotions due to weight and weight discrimination) and associations to behavior</li> <li>- exercises to identify associations between emotions and (eating) behavior[15]</li> <li>- exercises to build functional emotion regulation skills based on the Dialectical behavior therapy (DBT)[9], [16]</li> </ul> | <p>Self-assessment of affective consequences<br/>Self-monitoring of behavior<br/>Behavior substitution<br/>Behavioral experiments<br/>Emotional consequences<br/>Regulate negative emotions</p> | <p><b>Version A:</b></p> <ul style="list-style-type: none"> <li>- associations between cognition and dysfunctional beliefs (ABC model) [17]</li> <li>- focusing on rumination as dysfunctional emotion regulation strategy</li> </ul> <p><b>Version B:</b></p> <ul style="list-style-type: none"> <li>- identifying, labelling emotions, building up basic emotional competences (DBT manual) [16]</li> <li>- focusing on suppression as a dysfunctional emotion regulation strategy</li> </ul> |

|                                                                                                                                                                                                                                                                                                                                                                                                                                                    |                                   |                                                                                                                                                                                                                                                                                                                                                                                                                                           |                                                                                                                                                                             |                                                                                                                                                                                                                                                                                                                                                                                                                                                                                             |
|----------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|-----------------------------------|-------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|-----------------------------------------------------------------------------------------------------------------------------------------------------------------------------|---------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| <ul style="list-style-type: none"> <li>– Women tend to be more aware of their emotions and engage in more (mal)adaptive emotion regulation strategies than men [14]</li> </ul>                                                                                                                                                                                                                                                                     |                                   |                                                                                                                                                                                                                                                                                                                                                                                                                                           |                                                                                                                                                                             |                                                                                                                                                                                                                                                                                                                                                                                                                                                                                             |
| <ul style="list-style-type: none"> <li>– Men and women with overweight and obesity experience weight discrimination in multiple areas of life, gender difference in consequences and coping behavior [18], [19]</li> <li>– Men with obesity experience weight-loss as a competition and a project against themselves, commitment to “masculine” hard work [focus groups]* [20]</li> <li>– Men reported more physical and women reported</li> </ul> | <p><i>Consequences Module</i></p> | <ul style="list-style-type: none"> <li>- psychoeducation: general information about weight-related consequences (e.g., weight discrimination) [9]</li> <li>- associations between weight discrimination and weight management</li> <li>- exercises to improve self-esteem and body image[8], [15]</li> <li>- exercises to improve social competences (self-confident behavior) based on social competence group trainings [21]</li> </ul> | <p>Emotional consequences</p> <p>Social and environmental consequences</p> <p>Self-monitoring of behavior</p> <p>Social support (general)</p> <p>Behavioral experiments</p> | <p><b>Version A:</b></p> <ul style="list-style-type: none"> <li>- highlighting the emotional consequences of (internalized) weight discrimination</li> <li>- CBT-based tools to improve body image and social competences [9], [21]</li> </ul> <p><b>Version B:</b></p> <ul style="list-style-type: none"> <li>- highlighting the physical consequences of overweight</li> <li>- offering competitive challenges and tasks to improve physical well-being and social competences</li> </ul> |

|                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                           |                       |                                                                                                                                                                                                                                                                                                                                                                                                                                                                       |                                                                                                                                                                                                                                                              |                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                    |
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| more emotional consequences of overweight [focus groups]*                                                                                                                                                                                                                                                                                                                                                                                                                                                                 |                       |                                                                                                                                                                                                                                                                                                                                                                                                                                                                       |                                                                                                                                                                                                                                                              |                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                    |
| <ul style="list-style-type: none"> <li>- Association between weight, eating behavior and impulsivity [22], [23]</li> <li>- Men with obesity tend to prefer weight-loss programs which enable control and autonomy and promote problem-solving; loss of control is incoherent with male role [6], [7], [24]</li> <li>- Women with obesity reported higher levels of restraint eating, rigid avoidance of situations and food cues that trigger loss of control and a dichotomous thinking style [focus groups]*</li> </ul> | <i>Control Module</i> | <ul style="list-style-type: none"> <li>- psychoeducation: general information about the association between self-regulation and impulsivity and weight-related outcomes [8], [9], [15]</li> <li>- identify associations between loss of control eating and contextual or personal aspects</li> <li>- exercises to improve self-regulation in general and food-related inhibitory control in particular in individually meaningful critical situations [25]</li> </ul> | <p>Behavior substitution</p> <p>Behavioral rehearsal/practice</p> <p>Generalization of a target behavior</p> <p>Prompts/cues</p> <p>Self-monitoring of behavior</p> <p>Avoiding/changing exposure to cues for the behavior</p> <p>Behavioral experiments</p> | <p><b>Version A:</b></p> <ul style="list-style-type: none"> <li>- psychoeducation based on relatable case examples</li> <li>- differentiating eating types (e.g., restrictive eating)</li> <li>- CBT-based strategies to improve food-related inhibition (behavioral analysis)[8], [25]</li> </ul> <p><b>Version B:</b></p> <ul style="list-style-type: none"> <li>- psychoeducation based on relatable gender-specific statistics, facts, data (e.g., dual process theory)[26]</li> <li>- Go/No-Go training (gamification) tailored to individual attractive high-caloric food to improve food-related inhibition [27]</li> </ul> |

|                                                                                                                                                         |                             |                                                                                                                                                                                                    |                                                                                                                                                                                                                          |                                                                                                                                                                                                                                                                                                                                                                       |
|---------------------------------------------------------------------------------------------------------------------------------------------------------|-----------------------------|----------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|--------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|-----------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| - Lack of long-term regulation strategies [focus groups]*                                                                                               |                             |                                                                                                                                                                                                    |                                                                                                                                                                                                                          |                                                                                                                                                                                                                                                                                                                                                                       |
| - Self-efficacy is positively associated with weight management [28], [29]                                                                              | <i>Self-efficacy Module</i> | - psychoeducation: general information about eating and movement-specific self-efficacy                                                                                                            | Self-monitoring of behavior<br>Goal setting<br>Review behavior goal(s)<br>Social support (general)<br>Modeling of the behavior<br>Social comparison<br>Focus on past success<br>Verbal persuasion to boost self-efficacy | <b>Version A:</b><br>- focussing on improving mastery experiences (internal attribution) and social support<br>- CBT-based strategies to improve sources of efficacy beliefs<br><br><b>Version B:</b><br>- Approach-Avoidance Training (gamification) to improve food-related self-efficacy and offering competitive challenges to implement changes in everyday life |
| - Women and men that experienced successful long-term weight loss maintenance reported higher levels of self-efficacy [focus groups]*                   |                             | - association between self-efficacy, goal-setting and weight management[8]<br>- exercises to improve weight management-related self-efficacy based on Bandura's 4 sources of efficacy beliefs [30] |                                                                                                                                                                                                                          |                                                                                                                                                                                                                                                                                                                                                                       |
| - Men with obesity experience weight-loss as a competition and a project against themselves, commitment to "masculine" hard work [focus groups]* + [20] |                             |                                                                                                                                                                                                    |                                                                                                                                                                                                                          |                                                                                                                                                                                                                                                                                                                                                                       |

\* Results of qualitative content analyses based on focus groups with women ( $n = 18$ ) and men ( $n = 12$ ) with overweight or obesity.

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## 2.3 Studie 3: Differential effects of the individualized gender-sensitive mHealth intervention I-GENDO on eating styles in individuals with overweight and obesity – a randomized controlled trial

Die psychologische mHealth-App I-GENDO wurde mit dem Ziel entwickelt, dysfunktionales Essverhalten von Personen mit Übergewicht und Adipositas langfristig zu verändern. Wie in Studie 2 ausführlich beschrieben, forciert die Intervention die Förderung psychologischer Fähigkeiten, die für eine nachhaltige Veränderung dysfunktionalen Essverhaltens als relevant gelten (Teixeira et al., 2015; Varkevisser et al., 2019). Die entwickelte I-GENDO-App umfasst sieben aufeinander abgestimmte Module und ermöglicht eine individuelle Anpassung der Inhalte an die Bedürfnisse der Nutzenden.

Studie 3 untersucht die Wirksamkeit der App im Hinblick auf Veränderungen im Essverhalten sowie sekundär auf den BMI. Im Rahmen einer randomisierten kontrollierten Studie (RCT) wurde die App über einen Zeitraum von zwölf Wochen eingesetzt. Das Essverhalten der Teilnehmenden wurde zu Beginn der Intervention, unmittelbar nach deren Abschluss sowie 9 und 15 Monate nach Interventionsbeginn erfasst. Im Zentrum steht die Frage, ob die Nutzung der App zu einer Reduktion emotionalen und externalen Essverhaltens sowie zu einer Zunahme restriktiven Essverhaltens führt. Diese Veränderungen des Essverhaltens wurden in anderen Studien bereits mit einer langfristigen Reduktion des Körpergewichts in Verbindung gebracht (Teixeira et al., 2010, 2015).

Es wird angenommen, dass die Nutzung der App in der Interventionsgruppe im Vergleich zur Kontrollgruppe zu sowohl kurzfristigen als auch langfristigen Verbesserungen des Essverhaltens und darüber hinaus langfristig auch zu einer Reduktion des BMI beiträgt.

Studie 3 ist nachfolgend eingefügt.

### Literaturnachweis:

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***\*shared first authorship***

RESEARCH

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# Differential effects of the individualized gender-sensitive mHealth intervention I-GENDO on eating styles in individuals with overweight and obesity – a randomized controlled trial

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## Abstract

**Background** Addressing cognitive behavioral factors is associated with a favorable development of eating styles (i.e., increased levels of restrained eating, decreased levels of external and emotional eating) in individuals with overweight and obesity. Research suggests that the use of digital interventions that consider gender aspects regarding prevalence, comorbidities, and weight-related behaviors could enhance existing treatment options. This randomized controlled trial aimed to evaluate the effectiveness of the self-guided gender-sensitive mobile health intervention I-GENDO on restrained, emotional and external eating, body mass index, and physical activity at the end of the intervention, and at a 9- and 15-month follow-up.

**Methods** Two hundred thirteen individuals (67% female, body mass index:  $33.35 \pm 3.79$  kg/m<sup>2</sup>) were randomly assigned to the intervention or control group. Multilevel models were calculated to investigate differences between groups. I-GENDO offered interactive modules addressing psychological content associated with obesity. Users were able to self-tailor intervention content based on their individual needs and life realities.

**Results** Restrained eating was higher in the intervention group after the intervention (95% CI: 0.20, 0.36) and at 9-months (95% CI: 0.07, 0.24). At 9-months, emotional eating among women was lower in the intervention group compared to the control group (95% CI: -0.44, -0.19). In the intervention group, external eating was lower after the intervention, which remained significant for women at 9 (95% CI: -0.40, -0.19) and 15-months (95% CI: -0.34, -0.13). Body mass index of men in the intervention group was 1.44 lower at 15-months than in the control group. No significant effects on physical activity were found.

**Conclusions** The I-GENDO intervention was effective in changing restrained eating of both women and men in the long-term, suggesting that a self-guided, gender-sensitive approach is promising. However, the differential

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effects on the outcome measures indicate that more research is warranted to examine distinct gender-sensitive mechanisms of digital psychological interventions (i.e., dose–response relationship, blended counselling).

**Trial registration** ClinicalTrials.gov identifier: [NCT04080193](https://clinicaltrials.gov/ct2/show/study/NCT04080193), 06–09–2019.

**Keywords** Obesity, Overweight, mHealth, Digital health, Psychology, Cognitive behavioral therapy, Gender

## Background

A constant increase in body weight has been observed over the last few decades. Global prevalence rates estimate that in 2015, 1.9 billion adults worldwide were classified as overweight (body mass index, BMI:  $\geq 25.00$  kg/m<sup>2</sup>) of which 609 million were affected by obesity (BMI  $\geq 30.00$  kg/m<sup>2</sup>) [1]. The prevalence of overweight is approximately similar for women (38%) and men (37%), but women are more often affected by obesity (15%) than men (10%) [2]. Compared to men, women with overweight experience higher levels of weight discrimination [3] and weight dissatisfaction [4]. These experienced consequences tend to result in women initiating weight loss attempts more frequently than men [4], which increases the likelihood of weight-cycling and thus weight regain [5]. Overweight is associated with numerous adverse physical, psychological, and behavioral health outcomes. In addition to the short- and long-term physical health risks [6], individuals with overweight are at higher risk to experience adverse mental health outcomes such as depression and anxiety, lower self-esteem, body dissatisfaction, and self-efficacy [7, 8].

Eating styles, such as restrained, emotional and external eating, are known to be associated with weight loss and weight loss maintenance in individuals with overweight [9–11]. Restrained eating [12], that is, restricting food intake because of weight concerns, facilitates successful weight loss and weight loss maintenance [11]. In contrast, higher levels of reported emotional eating [12], that is, eating because of emotional states, such as anger or sadness, seem to present a barrier to weight loss [10, 13, 14] and pose a risk factor for weight regain after treatment [15]. The findings are inconclusive in studies investigating the impact of external eating [12], that is, eating because of external cues such as the sight or smell of food. Some studies found high external eating to be a barrier for long-term weight changes [9, 16], whereas some authors state that the extent of the influence of external eating on weight development is negligible [17].

These three eating styles are associated with different cognitive, emotional and behavioral abilities. For example, to successfully engage in restrained eating, a certain degree of self-control [18] and self-efficacy [19, 20] is necessary. Emotional eating often results from a lack of alternative coping strategies or emotion regulation skills needed for dealing with negative emotions or stressful

situations [21–23]. To be able to regulate nutrition intake based on physiological internal (i.e., hunger, satiety) instead of external cues (i.e., time of day, smell of a certain food), the ability to identify the underlying motivation for eating as well as a certain degree of food-related inhibitory control is needed [24, 25].

Studies comparing individuals with overweight with normal weight counterparts have shown that the psychological abilities described above differ between these two groups. More specifically, individuals with overweight show deficits in inhibitory control [26, 27], emotion regulation [28], and interoceptive awareness [29, 30]. Moreover, an enhanced reactivity to food cues is prevalent in this group [31]. These underlying psychological abilities can be addressed and augmented through treatment components of cognitive-behavioral therapy (CBT) for obesity, such as emotion regulation skills training, problem solving, cognitive restructuring, stimulus control training, and mindfulness interventions [32]. Implementing CBT is associated with short-term weight loss [33] and a favorable development of eating styles [34–36].

Cognitive-behavioral factors leading to and maintaining excess weight can strongly vary between individuals. A growing body of research suggests gender disparities in weight-related attitudes and psychological mechanisms arising from sociocultural and behavioral aspects of overweight that differ between gender [4, 5, 37, 38]. For example, across all weight categories, women are more likely to perceive their weight as higher than it actually is [39] and to experience higher levels of internalized weight bias [40], whereas men tend to have an inaccurate weight perception in the opposite direction [4, 39]. Furthermore, women are more likely to ruminate [41] and men are more likely to engage in thought suppression [42], both characterizing unfavorable cognitive emotion regulation strategies for the development of problematic eating behaviors. Therefore, gender-specific needs and life-realities need to be identified and integrated into treatment of overweight to target intervention content and enhance efficacy.

Such individualization can be implemented through tailored mobile health (mHealth) interventions [43]. Customization of intervention content can be achieved by self-tailoring (i.e., users actively select the content that matches their preferences and needs) and/or computer-based tailoring (i.e., an algorithm processes data

entered by users and assigns the most suitable intervention content) [44–46]. A recent meta analysis indicated that tailoring lifestyle interventions with regard to gender is promising but more research in this field is needed [47]. Hence, we developed an initial gender-sensitive intervention approach that allowed users to actively select treatment content individually to their needs (i.e., self-tailoring) regardless of their biological sex [48].

Various mHealth interventions have been shown to be effective as a treatment option for overweight [49]. They present an effective way to provide low-threshold, personalized treatment solutions that deliver a combination of multiple evidence-based treatment components [50]. Most mHealth research focuses on changes in weight and total nutrition or calorie intake [51, 52]. Eating styles are often examined as relevant outcome measures or mediator variables for weight management in experimental and face-to-face studies, but mHealth studies investigating the development of eating styles are lacking. Therefore, we examined whether an mHealth intervention influences these eating styles in a similar fashion.

Against this background, the aim of the I-GENDO project was the development and evaluation of a gender-sensitive individualized psychological multi-component mHealth intervention with self-tailoring and computer-based tailoring elements [48, 53]. The goal of the 12-week mHealth intervention was to target eating styles by focusing on underlying psychological and behavioral aspects. The app provided CBT components within seven modules: goal setting and motivation, stress management skills, emotion regulation skills, dealing with consequences of overweight, self-efficacy, self-regulation skills, and relapse prevention. The study aimed to achieve short-term improvements in eating styles and also to facilitate long-term changes in physical activity and body compensation (i.e., BMI) by implementing beneficial psychological strategies through an individualized gender-sensitive treatment approach.

The efficacy of the I-GENDO app was evaluated in a randomized controlled trial (RCT) with a post assessment and two follow-ups at 9 and 15 months. The primary aim was to enhance restrained eating and to reduce emotional and external eating (primary outcomes) over the course of the intervention and follow-up period. In the intervention group, we expected a greater decrease in emotional and external eating and an increase in restrained eating compared to the control group. Furthermore, we assumed long-term improvements in physical activity levels and a decrease in BMI in the intervention group compared to the control group (secondary outcomes).

## Methods

The study is reported in line with the CONSORT reporting guidelines ([54]; Additional file 1).

### Study design

The efficacy of I-GENDO was assessed in a RCT (NCT04080193; 06–09-2019; Additional file 2) with a wait-list control condition. Data was collected before the onset of the I-GENDO intervention (baseline), at 3 months (end of intervention), 9 months (follow-up 1) and 15 months (follow-up 2) after baseline. At each of these four assessments, participants answered an extensive online questionnaire and wore an accelerometer for seven consecutive days. The study was carried out in accordance with the Declaration of Helsinki. The Ruhr-University Bochum Institutional Review Board (No. 18–6415) as well as the ethics committee at the University of Bamberg approved this study. All participants were informed about the study and provided informed consent.

### Participants

Participants were recruited from August 2019 to August 2020 via study flyers, newspaper articles, social media, radio features, and oral presentations at weight loss rehab centers and clinical facilities. Participants interested in study participation were asked to complete an online survey to assess inclusion criteria and screen for exclusion criteria.

Participants were included if they a) were at least 18 years old; b) had a BMI between 30.00 and 39.99 kg/m<sup>2</sup> or a BMI between 25.00 and 29.99 kg/m<sup>2</sup> with weight-related health problems (e.g., type 2 diabetes, hypertension) or psychosocial distress; c) had access to a smartphone; d) were able to read, write and speak in German; and e) were motivated to lose weight. The latter was assessed by a single dichotomous item (“Do you currently intend to reduce your weight?”; yes/no). Exclusion criteria were a) current pregnancy; b) current (or within the last 12 months) involvement in a structured psychological weight loss program; c) current psychotherapeutic treatment of weight-related problems; d) previous or intended bariatric surgery; e) current regular intake of drugs that influence weight; f) untreated weight-related health problems (e.g., hypothyroidism, chronic disease, dyslipidemia); g) current substance abuse, major depression or suicidal ideation; h) binge eating disorder or bulimia nervosa according to DSM-5 criteria; and i) severe cognitive impairments. In case of reported suicidal intentions assessed with the PHQ-9 [55] or suspected eating disorder assessed with the Munich ED-Quest [56], individuals

were contacted via phone and subsequently diagnosed with structured interviews by experienced psychologists and eventually referred to suitable support services.

A total of 675 individuals completed the survey, of which 363 were excluded because they met at least one exclusion criterion, and 99 individuals could not be reached or lost interest in study participation. Finally, 213 eligible participants were included in the study. All participants were randomly assigned to one of the study arms, stratified by gender: I-GENDO intervention ( $n=116$ ,  $n_{\text{female}}=77$ ) or control condition ( $n=97$ ,  $n_{\text{female}}=66$ ), using a computerized electronic random number generator. The majority of the participants identified themselves as female ( $n=143$ ), 70 as male, and none as third gender.

An a priori power calculation revealed the need for  $n=64$  participants per group to discover a medium effect of group differences ( $\alpha=0.05$ ,  $1-\beta=0.80$ ). Dropout rates of 10% for each of the four assessments were expected, leading to a total of  $N=214$  participants needed to be recruited. We initially obtained 214 randomized participants, but one person withdrew from the study and requested deletion of data, resulting in a final analytic sample of 213 participants. See Fig. 1 for the CONSORT flow diagram.

### Procedure

Participants were invited to an in-person appointment at the study site in Bochum or Bamberg, Germany, where they received instructions about the procedure of the trial, installed the I-GENDO app on their personal smartphones (iOS or Android operating systems), answered questionnaires and received an accelerometer. Study staff was blinded to the group allocation of participants. The in-person appointments (i.e., study enrollment) were conducted between December 2019 and August 2020).

Participants were instructed to wear the accelerometer for seven consecutive days. After this assessment period, they were informed about their group allocation by e-mail. The interface of the app automatically switched from assessment mode (i.e., self-monitoring) to the control (i.e., number of days until the second questionnaire is available) or intervention (i.e., number of days until the intervention content is available) mode. On the next following Monday, the I-GENDO intervention was released to the intervention group. Participants in the control group received no intervention. After 3 months, both groups received the invitation to the second questionnaire, and the app interface switched back automatically to the assessment mode for all participants, based on their individual start day. Given the restrictions caused by the COVID-19 pandemic, no further in-person assessments could be conducted. Therefore, participants

received instructions by phone or mail, and accelerometers for the 7-day assessment period were sent by mail. This procedure was identical for the 9- and 15-month follow-up assessments (Fig. 2). Data was collected from December 2019 to November 2021.

All participants received a monetary compensation of a maximum of 100€ for each of the four assessments resulting in a maximum of 400€ each (30€ for completing the questionnaire, 10€/day for wearing the accelerometer for at least 10 h). After completion of the last assessment (15 months after baseline) all participants in both the intervention and control were granted access to the I-GENDO intervention.

### Intervention

The I-GENDO app is a 12-week self-guided multicomponent mHealth intervention that offered an individualized training program with seven modules primarily based on a CBT approach. The personalized assignment of the modules was based on the illness perceptions of each participant, measured by an adapted German version of the Illness-Perception Questionnaire (IPQ-R; [57, 58]). Individualization was implemented through self- and computer-based tailoring features. A detailed description of the I-GENDO intervention has been published previously [48].

The modules focused on different cognitive, emotional, and behavioral aspects related to weight loss management. These were a) goal setting and motivation; b) stress management skills; c) emotion regulation skills; d) dealing with consequences of overweight such as stigmatization and body dissatisfaction; e) self-efficacy; f) self-regulation skills; and g) relapse prevention. The modules were each offered in a female-targeted and a male-targeted version, which differed in terms of prioritization of topics, knowledge transfer, and communication style [48]. Participants were able to self-select one of the two offered module variations. They received a detailed description about the respective module content, but were not aware that the variations were based on a gender-specific rationale. Therefore, intervention content was not assigned due to biological sex or gender, but was assumed to be based on alignments with one's interests (i.e., gender-sensitive approach). This gender-sensitive approach was implemented to increase the relevance and appeal of each topic to all participants. A report about which gender variation was selected in the intervention group was published previously [48].

The training sessions within each module contained psychoeducational elements delivered through texts and videos and instructions for self-reflective and practical exercises (i.e., mindfulness exercises, behavioral rehearsal, self-monitoring of behavior, and social

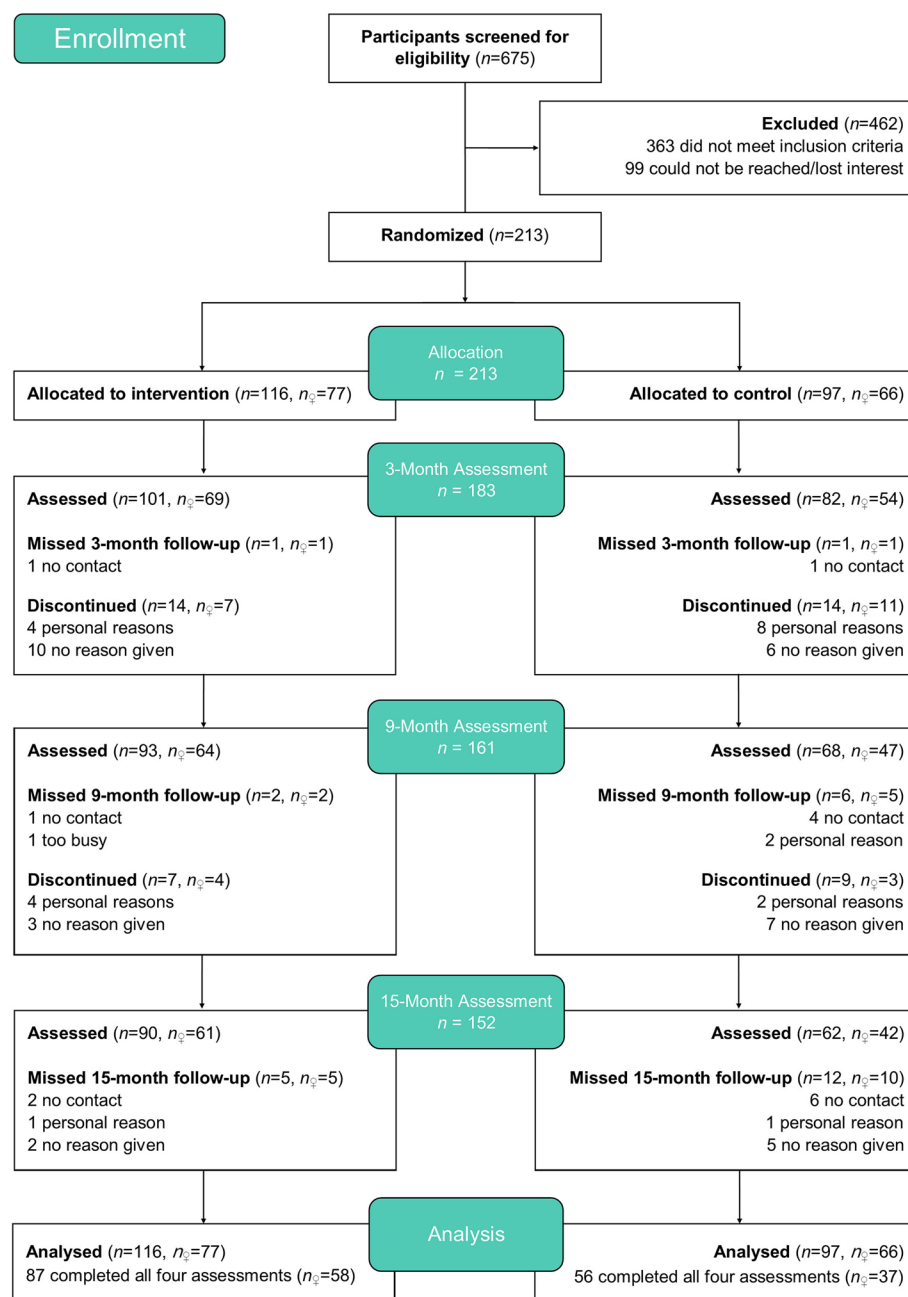


**Fig. 1** CONSORT flow diagram of the randomized controlled trial. Note.  $n$  = indicates the total number of participants included/excluded in the respective group at the respective point in time;  $n_{\text{♀}}$  = indicates the total number of female participants included/excluded in the respective group at the respective point in time

support). The modules were unlocked continuously over the course of 12 weeks. Additionally, the app included optional functions such as self-monitoring, homework sessions, and a toolbox to save favored items.

### Measures

Questions about age, gender, and anthropometry (i.e., weight, height) were included in the online questionnaires. BMI was calculated by dividing the reported body weight in kilograms by height in meters squared.

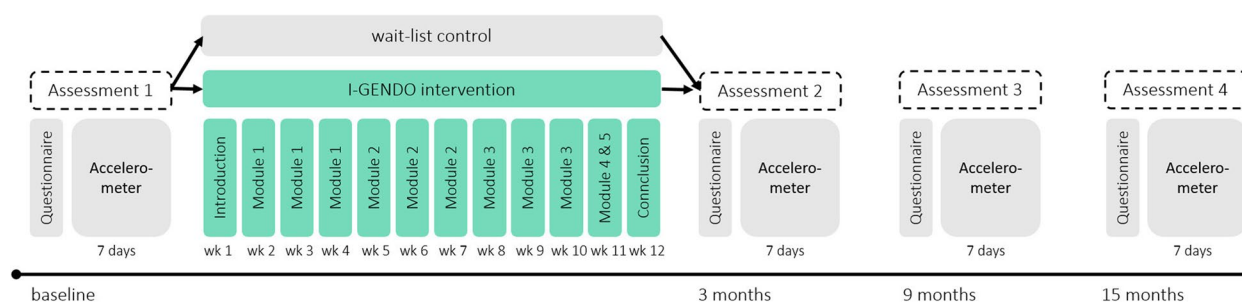


**Fig. 2** Intervention procedure and assessments

### Eating styles

The German version of the Dutch Eating Behaviour Questionnaire (DEBQ; [12, 59]) was used to assess eating styles. The questionnaire consists of 30 items with three subscales: emotional eating (i.e., eating because of different emotional states, such as anger or sadness), restrained eating (i.e., restricting food intake because of weight concerns) and external eating (i.e., eating because of external cues, such as the sight or smell of delicious food). Participants recorded their degree of agreement to each statement from 1 (never) to 5 (very often). Mean scores for each subscale were calculated. Higher values indicate a stronger expression of the corresponding eating style.

### Device-based measured physical activity

Physical activity (i.e., step count) was measured continuously over the course of the four 7-day assessment periods using the tri-axial ActiGraph® wGT3X-BT accelerometer (firmware v1.9.2, ActiGraph, Pensacola, FL, USA), which was attached to an elastic waist belt. Participants were instructed to position the sensor on the right hip, which was found to be a good placement for the assessment of everyday physical activity [60]. Participants were instructed to wear the accelerometer during waking hours for seven consecutive days and to only take it off while showering or participating in other water-related activities. Raw data was sampled at an input frequency of 30 Hz and initially stored on the device. The ActiLife® software (version 6.13.4; ActiGraph, Pensacola, FL, USA) was used to process the raw data into meaningful step count. Participants were required to provide at least 10 h of wear time per day (valid day) for at least four days in each assessment week to be included in the analysis. Average step count per day was calculated by dividing the total amount of steps of valid days by the number of valid days.

### Statistical analyses

Descriptive analyses were conducted using percentages and frequencies for categorical variables, as well

as means and standard deviations for continuous variables. Comparisons of socio-demographic variables and baseline values between the intervention and control group and between male and females within each group were tested using chi-square distributions (categorical) and analyses of variance (ANOVA; continuous variables). Linear multilevel regression models were estimated using maximum likelihood to analyze the impact of the intervention (i.e., I-GENDO, control), time (i.e., baseline, 3, 9 and 15 months), gender (female, male) and the intervention-by-time interaction. A two-level model structure including a random intercept was applied. To examine the specific intervention effect on each outcome, five separate models were specified for each dependent variable (restrained, emotional, and external eating, BMI, step count). All reported models were adjusted for the baseline value of the outcome variable (see Additional file 3 for models without adjustment of baseline values). Mean values of each outcome were estimated at 3, 9 and 15 months for both groups and differences between the intervention and control group were calculated.

To test for potential effect modification by gender, group\*time\*gender interaction terms were added to the models, and the interaction term remained in the final model when significant interactions with gender were detected, and estimates were reported separately for men and women. Intraclass correlation coefficients (ICCs) of the null models indicated that 62% (restrained eating), 79% (emotional eating), 75% (external eating), 91% (BMI), and 62% (step count) of the differences were due to between-person effects.

SPSS 28 (IBM Corp, Armonk, NY, USA) and different packages of R [61] and Rstudio [62] were used for all analyses. The 'ggplot2' package (v 3.3.5) was used for visualizations [63], multilevel models were calculated using the 'nlme' package (v. 3.1 – 155; [64]), and model assumptions were checked using the 'performance' package in R (c. 0.8.0; [65]). The results tables of the regression analyses were generated using the 'sjPlot'

package (v 2.8.10; [66]). Level for significance was set a priori to  $p < 0.05$ .

## Results

No significant baseline differences in sociodemographic variables between the two study groups were detected (Table 1). However, women in the control group were significantly younger than men in the control group ( $F(1, 209) = 7.07$ ,  $p = 0.008$ , partial  $\eta^2 = 0.033$ ) and women in the control and intervention group reported significantly higher scores on the emotional eating scale than male participants in the respective groups ( $F(1, 209) = 14.40$ ,  $p < 0.001$ , partial  $\eta^2 = 0.064$ ). Significantly more individuals in the intervention group ( $n = 87$ ) completed all four assessments than in the control group ( $n = 56$ ;  $\chi^2(1) = 6.38$ ,  $p = 0.012$ ).

Table 2 displays the model-estimated means, standard errors, 95% confidence intervals (CI) and between-group difference at 3, 9 and 15-month assessments adjusted for baseline value from fitted maximum likelihood repeated measures mixed models for the self-reported outcomes.

Individuals in the intervention group reported significantly higher scores for restrained eating than participants in the control group at 3-month ( $\beta = 0.47$ ,  $p < 0.001$ ) and 9-month ( $\beta = 0.26$ ,  $p = 0.033$ ) assessment. As shown in Table 2, the difference was 0.28 at 3 months (95% CI: 0.20, 0.36) and decreased towards 0.15 at 9 months (95% CI: 0.07, 0.24). Although higher values were reported by the intervention group compared to the control group after 15 months (difference: 0.13, 95% CI: 0.04, 0.22),

this difference was only marginally significant ( $\beta = 0.23$ ,  $p = 0.069$ ). We found no gender differences in intervention effects.

A gender-specific effect of the intervention was found for emotional eating, as indicated by a significant interaction between group, time, and gender. Women in the intervention group reported significantly lower emotional eating at the 9-month assessment compared to women in the control group ( $\beta = -0.34$ ,  $p = 0.013$ ; difference  $-0.32$ , 95% CI:  $-0.44$ ,  $-0.19$ ). No significant differences were found immediately after the intervention (3 months;  $\beta = -0.15$ ,  $p = 0.260$ ) or in the long-term (15 months;  $\beta = -0.23$ ,  $p = 0.103$ ). Men reported no significantly different values across groups at any assessment, indicating that the intervention had no significant effect on emotional eating in men (all  $ps > 0.10$ ).

Women and men in the intervention group reported significant lower levels of external eating than participants in the control group. Females in the intervention group reported decreased levels of external eating in comparison to the women in the control group at the end of the intervention (difference at 3 months:  $-0.20$ , 95% CI:  $-0.30$ ,  $-0.10$ ;  $\beta = -0.26$ ,  $p = 0.031$ ) and at follow-up (difference at 9 months:  $-0.29$ , 95% CI:  $-0.40$ ,  $-0.19$ ,  $\beta = -0.39$ ,  $p = 0.002$ ; difference at 15 months:  $-0.23$ , 95% CI:  $-0.34$ ,  $-0.13$ ;  $\beta = -0.31$ ,  $p = 0.017$ ). In males, external eating was only significantly lower in the intervention group immediately after receiving the intervention (difference at 3 months:  $-0.30$ , 95% CI:  $-0.45$ ,  $-0.15$ ;  $\beta = -0.31$ ,  $p = 0.016$ ).

**Table 1** Baseline characteristics

| Variables                                 | Overall                 |                               | Control             |                   | Intervention        |                   |
|-------------------------------------------|-------------------------|-------------------------------|---------------------|-------------------|---------------------|-------------------|
|                                           | Control<br>( $n = 97$ ) | Intervention<br>( $n = 116$ ) | Female ( $n = 66$ ) | Male ( $n = 31$ ) | Female ( $n = 77$ ) | Male ( $n = 39$ ) |
| Demographics                              |                         |                               |                     |                   |                     |                   |
| Age (in years); $M$ ( $SD$ )              | 45.45 (12.66)           | 47.27 (11.65)                 | 43.24 (12.86)*      | 50.16 (11.00)     | 46.40 (12.22)       | 49.00 (10.38)     |
| High School Degree; $n$ (%)               | 25 (25)                 | 36 (31)                       | 17 (26)             | 8 (26)            | 25 (32)             | 11 (28)           |
| Married or living with a partner; $n$ (%) | 79 (81)                 | 91 (78)                       | 52 (79)             | 27 (87)           | 57 (74)             | 34 (87)           |
| Weight and body composition               |                         |                               |                     |                   |                     |                   |
| Weight (in kg); $M$ ( $SD$ )              | 97.65 (14.84)           | 98.34 (15.39)                 | 94.24 (13.43)       | 104.90 (15.31)    | 93.44 (12.56)       | 108.03 (16.02)    |
| BMI (in kg/m <sup>2</sup> ); $M$ ( $SD$ ) | 33.07 (3.79)            | 33.58 (3.79)                  | 33.23 (3.74)        | 32.72 (3.92)      | 33.75 (3.69)        | 33.23 (4.02)      |
| Eating Styles                             |                         |                               |                     |                   |                     |                   |
| Restrained Eating; $M$ ( $SD$ )           | 2.80 (0.58)             | 2.70 (0.58)                   | 2.83 (0.58)         | 2.75 (0.58)       | 2.78 (0.55)         | 2.55 (0.62)       |
| Emotional Eating; $M$ ( $SD$ )            | 3.12 (0.95)             | 3.05 (1.03)                   | 3.36 (0.86)***      | 2.59 (0.94)       | 3.30 (0.95)***      | 2.57 (1.02)       |
| External Eating; $M$ ( $SD$ )             | 3.47 (0.62)             | 3.48 (0.67)                   | 3.54 (0.65)         | 3.33 (0.54)       | 3.52 (0.66)         | 3.42 (0.71)       |
| Physical activity <sup>a</sup>            |                         |                               |                     |                   |                     |                   |
| Step count per day; $M$ ( $SD$ )          | 7296 (3020)             | 6831 (2251)                   | 7196 (2756)         | 7505 (3559)       | 6765 (1965)         | 6966 (2776)       |

BMI body mass index. Asteriks in column 4 (control/female) and column 6 (intervention/female) indicate significant baseline differences between female and male participants in the respective group. \* $p < 0.05$ , \*\*\*  $p < 0.001$

<sup>a</sup>  $n = 194$

**Table 2** Model-estimated means, standard errors, and 95%CI for all outcomes at 3, 9 and 15 months

|                          | 3 months |        |                    |              |        |                    | 9 months                          |        |                |              |        |                    | 15 months |        |                    |              |        |                    |
|--------------------------|----------|--------|--------------------|--------------|--------|--------------------|-----------------------------------|--------|----------------|--------------|--------|--------------------|-----------|--------|--------------------|--------------|--------|--------------------|
|                          | Control  |        |                    | Intervention |        |                    | Between-group difference [95% CI] |        |                | Intervention |        |                    | Control   |        |                    | Intervention |        |                    |
|                          | Mean     | SE     | 95% CI             | Mean         | SE     | 95% CI             | Mean                              | SE     | 95% CI         | Mean         | SE     | 95% CI             | Mean      | SE     | 95% CI             | Mean         | SE     | 95% CI             |
| Restrained               |          |        |                    |              |        |                    |                                   |        |                |              |        |                    |           |        |                    |              |        |                    |
| Overall                  | 2.85     | 0.05   | [2.76, 2.94]       | 3.13         | 0.04   | [3.05, 3.21]       | 0.28 [0.20, 0.36]                 | 0.05   | [0.00, 0.10]   | 2.85         | 0.05   | [2.76, 2.95]       | 3.00      | 0.04   | [2.92, 3.09]       | 2.78         | 0.05   | [2.68, 2.89]       |
| Emotional <sup>a</sup>   |          |        |                    |              |        |                    |                                   |        |                |              |        |                    |           |        |                    |              |        |                    |
| Male                     | 3.09     | 0.10   | [2.89, 3.28]       | 2.94         | 0.09   | [2.76, 3.12]       | -0.15 [-0.33, 0.03]               | 0.11   | [0.00, 0.22]   | 2.88         | 0.11   | [2.66, 3.10]       | 3.03      | 0.10   | [2.84, 3.22]       | 2.97         | 0.12   | [2.74, 3.19]       |
| Female                   | 3.12     | 0.07   | [2.98, 3.26]       | 2.98         | 0.06   | [2.86, 3.10]       | -0.14 [-0.27, -0.02]              | 0.08   | [0.00, 0.16]   | 3.34         | 0.08   | [3.19, 3.49]       | 3.03      | 0.07   | [2.90, 3.15]       | 3.22         | 0.08   | [3.07, 3.38]       |
| External <sup>a</sup>    |          |        |                    |              |        |                    |                                   |        |                |              |        |                    |           |        |                    |              |        |                    |
| Male                     | 3.47     | 0.08   | [3.31, 3.63]       | 3.17         | 0.08   | [3.02, 3.32]       | -0.30 [-0.45, -0.15]              | 0.09   | [0.00, 0.18]   | 3.32         | 0.09   | [3.14, 3.49]       | 3.37      | 0.08   | [3.21, 3.52]       | 3.36         | 0.09   | [3.17, 3.54]       |
| Female                   | 3.56     | 0.06   | [3.45, 3.68]       | 3.37         | 0.05   | [3.27, 3.47]       | -0.20 [-0.30, -0.10]              | 0.06   | [0.00, 0.12]   | 3.57         | 0.06   | [3.45, 3.69]       | 3.28      | 0.05   | [3.17, 3.38]       | 3.44         | 0.06   | [3.32, 3.57]       |
| BMI (kg/m2) <sup>a</sup> |          |        |                    |              |        |                    |                                   |        |                |              |        |                    |           |        |                    |              |        |                    |
| Male                     | 33.41    | 0.28   | [32.86, 33.96]     | 32.58        | 0.26   | [32.07, 33.09]     | -0.84 [-1.35, 0.33]               | 0.32   | [0.00, 0.64]   | 33.74        | 0.32   | [33.12, 34.36]     | 32.73     | 0.27   | [32.20, 33.27]     | 33.69        | 0.32   | [33.05, 34.32]     |
| Female                   | 33.00    | 0.20   | [32.61, 33.39]     | 32.83        | 0.18   | [32.48, 33.18]     | -0.17 [-0.52, 0.18]               | 0.21   | [0.00, 0.42]   | 32.88        | 0.21   | [32.46, 33.29]     | 33.06     | 0.18   | [32.69, 33.42]     | 32.63        | 0.22   | [32.19, 33.06]     |
| Step count/ day          |          |        |                    |              |        |                    |                                   |        |                |              |        |                    |           |        |                    |              |        |                    |
| Overall                  | 6793.14  | 319.25 | [6167.43, 7418.85] | 6867.78      | 273.09 | [6332.56, 7403.01] | 7464 [-460.58, 609.87]            | 241.01 | [0.00, 482.01] | 6547.14      | 241.01 | [6074.77, 7019.50] | 6777.69   | 192.97 | [6399.47, 7155.91] | 6836.39      | 243.61 | [6358.93, 7313.85] |

Note. Bold text indicates significant between-group effects. Displayed are the results of the multilevel model analysis for each outcome (restrained eating, emotional eating, external eating, BMI, step count/day) adjusted for baseline value and assessment (3 months, 9 months, 15 months). Each model contained an interaction term for time\*group and, in case the interaction was significant, an interaction for time\*group\*gender

<sup>a</sup> Estimates were reported separately for men and women if a significant group\*time\*gender interaction was detected

Compared with the control group, the assignment of the intervention resulted in a statistically significant long-term weight loss for men (difference at 15 months: -1.44, 95% CI: -1.97, -0.91;  $\beta = -0.36$ ,  $p < 0.001$ ). Immediately after the intervention the difference was -0.84 (95% CI: -1.35, 0.33;  $\beta = -0.21$ ,  $p = 0.016$ ) and increased to -1.00 BMI points (95% CI: -1.54, -0.47;  $\beta = -0.25$ ,  $p = 0.008$ ) at 9 months. The intervention had no significant effect on women's BMI. Figure 3 displays the between-group differences for each outcome at each assessment.

No baseline adjusted differences between men and women at 3 (74.64, 95% CI: -460, 609), 9 (230, 95% CI: -147, 608) and 15 months (277, 95% CI: -91, 646) were found between the intervention and control group for step count, indicating that the intervention had no effect on this physical activity measure (Additional file 4).

## Discussion

The aim of this RCT was to investigate whether a gender-sensitive psychological mHealth intervention based on CBT improves eating styles by addressing the underlying psychological skills. Overall, our mHealth intervention achieved favorable long-term (15 months) changes in restrained eating for women and men and in external eating for women. Additionally, the I-GENDO intervention led to a statistically significant decrease in men's BMI.

## Restrained eating

Our results show that men and women in the intervention group, compared to controls, showed improvements in restrained eating immediately after the intervention (three months after baseline), which were also observed at follow-up at 9-months and, with marginal significance at 15 months. This result is promising because in face-to-face intervention studies increased levels of restrained eating are known to be predictors of weight loss and weight loss maintenance [11] and related to long-term success [67]. Research also shows that restrained eating has a preventive effect on weight gain, even when eating habits that are normally associated with weight gain are prevalent, for example, loss of control eating [17].

Bijholt and colleagues [68] investigated women during the postpartum period with a history of excessive gestational weight gain using the INTER-ACT mHealth intervention in combination with face-to-face contact. They also found a favorable increase of restrained eating, but the effect was only short-term immediately after the intervention and was not evident at the 6 month follow-up [68]. In our study, the effect was still present at 9 months, and it was also present in men. While the general principles of the INTER-ACT intervention were goal setting and motivational tips [69], the I-GENDO intervention included highly interactive and

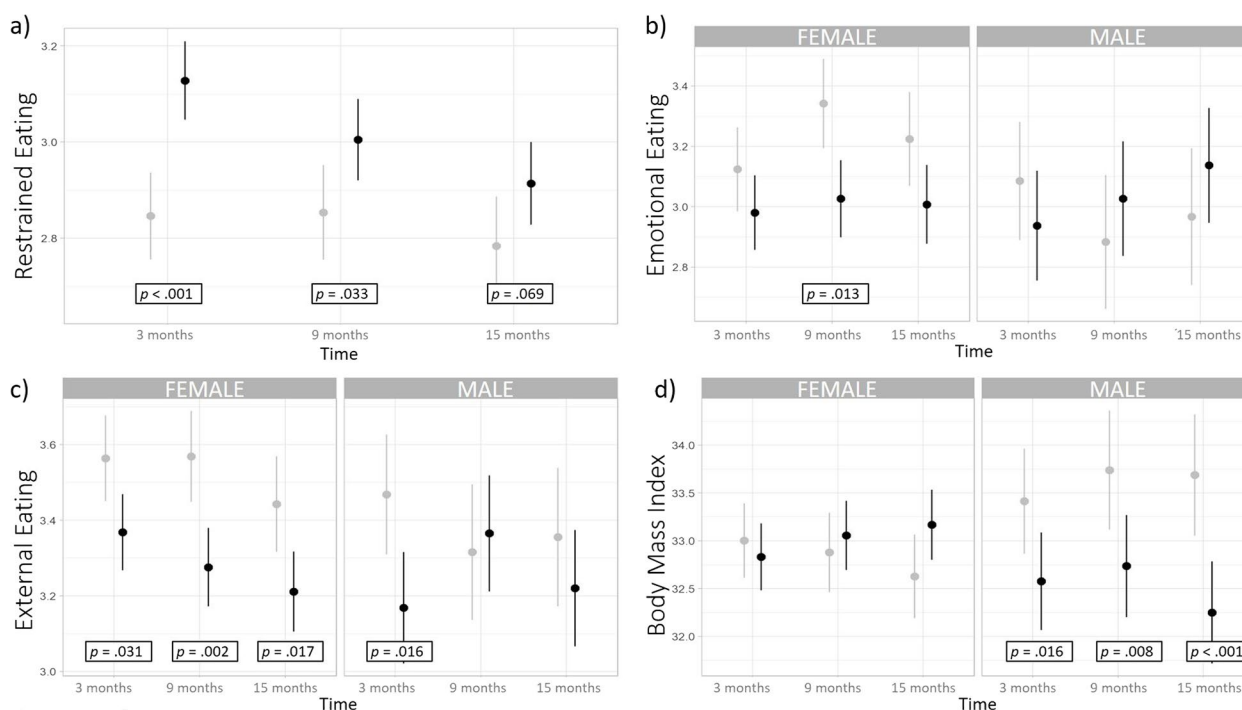


**Fig. 3** Intervention effect for each outcome at each assessment. Note. Between-group differences (black = intervention group, gray = control group) adjusted for baseline value for **a**) restrained eating, **b**) emotional eating, **c**) external eating, **d**) BMI at each assessment for each gender. Significant ( $p < .05$ ) and marginally significant interactions ( $p < .10$ ) are indicated by the p value

cognitive demanding content for knowledge acquisition, self-reflection, and exercises for knowledge transfer. These behavior change techniques and components of CBT are also implemented in effective face-to-face studies addressing eating styles [36]. Overall, increasing restrained eating plays an important role in conventional obesity treatments, and we showed that these sustained effects can also be reached by using our I-GENDO mHealth intervention.

### Emotional eating

Contrary to assumptions, the I-GENDO intervention elicited no long-term changes in emotional eating in either men or women. We only observed an effect after 9 months in women, which was not maintained at 15 months. This was unexpected because emotional eating is associated with a decreased ability to regulate emotions [70], and the intervention content was specifically designed to empower the participants to identify unfavorable emotion regulation strategies (i.e., eating to suppress feelings, rumination) and to adapt and build substantial emotional competences.

These findings may be related to the challenges posed by the digital implementation of emotion regulation strategies. CBT has been shown to be effective in the treatment of obesity in face-to-face settings [34]. Therefore, the I-GENDO intervention included several evidence-based CBT principles that targeted emotional competences (i.e., identify warning signs, build helpful habits, problem solving, and relaxation). Studies investigating the effects of self-guided digital interventions in non-clinical samples showed that the digital adaptation of CBT successfully led to favorable changes in stress, mindfulness, and eating behaviors [71, 72]. Nevertheless, a lack of studies have validated the effectiveness of CBT strategies that target emotion regulation in mHealth programs for the specific target group of individuals with overweight and obesity [73, 74]. Therefore, we question whether a self-guided mHealth environment represented a feasible approach to substantially change emotional processes in emotionally burdened individuals as in the present sample. These considerations are particularly reasonable in light of the fact that meaningful differences in restrained eating were elicited by the I-GENDO intervention. In such conditions, the cognitive approach of an mHealth intervention may be more suitable because restrained eating behavior is associated with predominantly cognitive processing (i.e., goal activation) and executive functions (i.e., inhibition control) [75, 76]. Thus, we assume that to significantly change emotional strategies an individualized blended intervention approach or even a face-to-face setting is needed.

Another possible explanation for the lack of long-term changes in emotional eating might be that participants differ in the level of knowledge and awareness about the effects of emotions on eating. Thus, participants who have less access to their emotions might need more support and time gaining insight into emotions and possibly need more time practicing new emotion regulation skills, whereas those aware of their emotions and individual emotion-regulation skills could find cognitive restructuring more helpful [77]. A noteworthy consideration is that the time and dose offered by the I-GENDO intervention was not sufficient to change emotional processes. Our results suggest that access to own emotions, emotion regulation strategies already used, and the degree of trait emotional intelligence should be assessed before the beginning of the intervention [21]. The intervention should then be adapted accordingly to the affect-related psychological needs of the person.

### External eating

The intervention was effective for female participants immediately after the intervention and at both 9-month and 15-month assessment compared to the control group. In contrast to our expectations, we observed an intervention effect for male participants only immediately after the intervention, not at the 15-month follow-up. A pronounced external eating style is associated with a reduced ability to perceive internal bodily cues (i.e., hunger, satiety) [78] and a higher attentional bias for food cues [24, 79]. Furthermore, external eating is associated with overconsumption [17], binge eating [80], and food craving [16].

A review of mHealth interventions in obesity treatment that focus on changing external eating showed that such interventions focus predominantly on promoting mindfulness-based eating awareness. This strategy is considered as an antagonist of external eating because it represents the ability to perceive internal signals (i.e., hunger, satiety) and to guide eating behavior accordingly [81]. The main criticism of the reviewed studies was that the key features of the apps (i.e., eating timers, hunger rating apps, diaries) were not sufficient to establish a mindfulness-based eating style. In contrast, our multibehavioral I-GENDO intervention offered more comprehensive and diverse features developed to teach mindful eating as an alternative strategy to external eating (i.e., guided eating meditations, strategies involving the five senses, integration of mindfulness into daily life). These aspects might explain why participants in our study had favorable values in external eating immediately after the end of the intervention. However, an interesting finding is that the effect was not maintained for men. We assume that women benefitted in the long-term because

they might have adopted the strategies and mindset into their everyday life. This is reasonable since research indicates that women tend to benefit more from mindfulness interventions than men [82].

### BMI and physical activity

Our intervention led to a small but sustained BMI decrease in men, which was statistically significant but not clinically relevant (<5% weight loss). Furthermore, we found no improvements in physical activity in the intervention group for men and for women. The I-GENDO intervention primarily sought to change psychological aspects of eating behavior and eating styles. We had no assumptions that our intervention would have a short-term impact on weight or exercise behavior because we prescribed no specific nutritional or activity recommendations (such as low-fat diet or minimum step count). However, we assumed that BMI would decrease and that physical activity would increase in the long-term. We hypothesized that learned psychological skills and strategies such as goal setting might also affect physical activity and that improving eating styles would also affect weight development, but we found no evidence for these effects. Apparently, working primarily on psychological factors associated with weight management had no clinically relevant effect on BMI or physical activity in the long-term. However, mHealth studies that have provided specific behavioral instructions also show only ambiguous or inconsistent results on the clinical relevance of weight loss or long-term effects [83].

Perhaps an mHealth intervention would be more beneficial on the BMI or physical activity, if an individualized CBT-based mHealth approach was combined with concrete behavioral suggestions such as calorie restrictions or a daily exercise goal. Just-in-time-interventions that offer treatment strategies tailored to the actual behavior show promising results for increasing physical activity [84]. However, a stand-alone self-guided mHealth intervention might not be sufficient enough to substantially change behavioral outcomes and perhaps should therefore be combined with traditional face-to-face approaches.

### Limitations and strengths

Our study has some noteworthy limitations. First, the significant differences in attrition rates between the control and intervention group represent a weakness of the study (dropout rates: 42% vs. 25%). Although participants in the control group were given access to the app after the end of the study, and the financial incentives were the same for both groups, being assigned to the control condition during this phase

of behavior change (i.e., motivation to lose weight, high expectancies) could have understandably elicited frustration and contributed to a higher dropout. This phenomenon has also been observed in comparable mHealth RCTs [85]. We considered these differences by implementing a multilevel model approach, which is robust to the biases of missing data and represents an intention-to-treat approach [86]. Second, we verified that all participants were motivated to reduce weight, but since no validated questionnaire was used, we cannot explore the extent to which specific motivations for weight loss (i.e., health, appearance, social pressure) have affected study participation. Third, our app allowed users to independently select one of two gender-specific variants for each module and was thus gender-sensitive (self-tailoring). Although this innovative technological approach is very promising because of the established sex differences in obesity treatment, the lack of a comparison group with a non-gender-sensitive app precludes the conclusion that this gender-sensitive structure contributed to greater effects. This comparison still needs to be verified in future studies.

Moreover, this study was conducted over the course of the COVID-19 pandemic. Due to the different times of study enrollment and data assessment periods, it is not possible to systematically investigate whether or to what extent different restrictions in the different parts of Germany may have influenced the study implementation and results. This should be noted as a potential influencing factor, as there are recent studies showing that the pandemic had an impact on various health behavior [87, 88]. Furthermore, the periodic contact restrictions have hindered the objective collection of anthropometric data at the study sites.

A strength of the current study is that the development of the I-GENDO intervention was guided by a participative and iterative research process, actively involving patients as well as experts in the treatment of obesity. Overall, the intervention was well received by the participants [48] and compared to other lifestyle mHealth self-monitoring intervention groups (range: 5%–55%), we observed a relatively low drop-out rate in the intervention group (25%) by the 15 month [89]. Most interventions in obesity treatment do not take different gender preferences into account [90]. Therefore, we developed a gender-sensitive, computer- and self-tailored intervention, which reflects an attempt to integrate a gender-sensitive approach. Our results show that we succeeded in designing a self-guided mHealth approach, that targets women and men, which results in differential but favorable effects for both genders.

## Conclusion

This study demonstrated that the gender-sensitive multi-component self-guided mHealth intervention I-GENDO provides long-term benefits from restrained eating for women and men with overweight and obesity who are motivated to lose weight but not from emotional eating and only beneficial changes in external eating for women. We assume that restrained eating might be feasible to target with a CBT-based mHealth approach because it is associated with more cognitive processes that can be implemented and modified in a self-guided manner. In contrast, emotional processes that are associated with emotional eating might be better addressed via blended counseling approaches because they allow a more profound examination and interaction with these topics in face-to-face settings. For BMI and physical activity, the stand-alone I-GENDO intervention elicited no clinical meaningful effects. Therefore, we recommend our gender-sensitive mHealth intervention especially when the focus is on changing restrained eating behavior (i.e., individuals with decreased food-related inhibitory control). For further outcome measures associated with weight management, like emotional eating, BMI, and physical activity, our app is not sufficient alone and can therefore be recommended as a valuable add-on treatment in combination with a face-to-face intervention.

## Supplementary Information

The online version contains supplementary material available at <https://doi.org/10.1186/s44247-023-00041-0>.

**Additional file 1.** Reporting checklist for randomized trial.

**Additional file 2.** Content of the PRE-registration.

**Additional file 3: Table A1.** Model-estimated means, standard errors, and 95%CI for the self-reported outcomes at 3, 9 and 15 months, not adjusted for baseline value.

**Additional file 4: Figure A1.** Intervention effect for the physical activity outcome at each assessment.

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## Authors' contributions

CS, TF, MP, SS, JW, SSL, and SH designed the study. CS, TF, and MP collected the data, and formulated the study question. CS, TF, NS, and AD performed the data analysis, data interpretation, and generation of figures and tables. JW was responsible for preparing the accelerometer data for statistical analysis. CS, TF, and NS drafted the manuscript. JW, MP, AD, SH, and SSL contributed to the final version of the manuscript. All authors reviewed and approved the final manuscript.

## Authors' information

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## Availability of data and materials

The intervention content used and the datasets analysed during the current study are available from the corresponding author on reasonable request. Analysis code is available at the Open Science Framework (<https://osf.io/r4p9d/#>).

## Declarations

### Ethics approval and consent to participate

The study was carried out in accordance with the Declaration of Helsinki. The Ruhr-University Bochum Institutional Review Board (No. 18–6415) as well as the ethics committee at the University of Bamberg approved this study. All participants were informed about the study and provided informed consent.

### Consent for publication

Not applicable.

### Competing interests

The authors declare no competing interests.

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## ADDITIONAL FILE 3

**Table A1** Model-estimated means, standard errors, and 95%CI for the self-reported outcomes at 3, 9 and 15 months, not adjusted for baseline value.

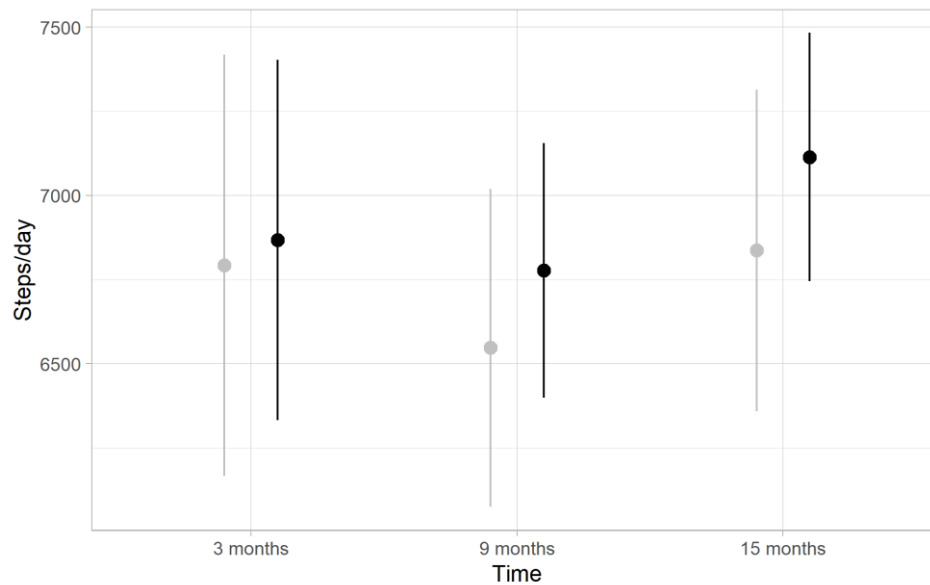
Estimates were reported separately for men and women if a significant group\*time\*gender interaction was detected.

*Note.* Bold font indicate significant between-group effects. Displayed are the results of the multilevel model analysis for each outcome (restrained eating, emotional eating, external eating, BMI, step count/day) and assessment (3 months, 9 months, 15 months). Each model contained an interaction term for time\*group and, in case the interaction was significant, an interaction for time\*group\*gender.

ADDITIONAL FILE 4

Differential Effects of the Individualized Gender-Sensitive mHealth Intervention I-GENDO on Eating Styles in Individuals with Overweight and Obesity – A Randomized Controlled Trial; Seiferth, C.; Färber, T.; Pape, M.; Schoemann, N.; Dieberger, A.; Schroeder, S.; Herpertz, S.; Wolstein, J.; Steins-Loeber, S.

**Figure A1.** Intervention effect for the physical activity outcome at each assessment.



*Legend.* Between-group differences (black = intervention group, gray = control group) adjusted for baseline value for step count per day at each assessment.

### 3 Diskussion

Die vorliegende Dissertation untersuchte, inwieweit dysfunktionales Essverhalten bei Personen mit Übergewicht und Adipositas durch eine psychologische mHealth-Intervention wirksam verändert werden kann. Ausgangspunkt war die Annahme, dass langfristig stabile Verhaltensänderungen nur dann erreichbar sind, wenn die dem dysfunktionalen Essverhalten zugrunde liegenden psychologischen Prozesse verändert werden. Die Ergebnisse der drei durchgeführten Studien zeigen, dass eine solche Veränderung teilweise möglich ist, verdeutlichen jedoch zugleich die Grenzen einer alleinstehenden mHealth-Intervention.

Erstens zeigen die Befunde zur Rolle gewichtsbezogener Stigmatisierung, dass dysfunktionales Essverhalten nicht ausschließlich als individuelles Problem verstanden werden kann, sondern wesentlich durch externe Belastungsfaktoren mitgeprägt ist. Die Internalisierung von Stigmatisierung zeigte sich in Studie 1 unabhängig vom BMI als vermittelnder Mechanismus zwischen Stigmatisierungserfahrung und emotionalem Essverhalten. Bei Personen mit Normalgewicht erklärt sie zudem den Zusammenhang mit restriktivem Essverhalten, das potenziell einer Gewichtszunahme entgegenwirken kann (Teixeira et al., 2010; van Strien et al., 2009). Die Ergebnisse unterstreichen die Bedeutung und den Druck gesellschaftlicher Körnernormen für die Entwicklung und Aufrechterhaltung dysfunktionalen Essverhaltens, das in diesem Kontext womöglich als Bewältigungsstrategie verstanden werden kann. Zweitens konnte anhand der Entwicklung und Evaluation der I-GENDO-App gezeigt werden, dass es grundsätzlich möglich ist und sinnvoll ist, eine mHealth-Intervention zu entwickeln, die Interventionsinhalte basierend auf psychologischen Ausgangsvariablen bereitstellt. Damit wird das Potenzial von mHealth-Interventionen, eine individualisierte Unterstützung zu ermöglichen, deutlich. Drittens konnte mit der randomisierten kontrollierten Studie gezeigt werden, dass die entwickelte Intervention insbesondere restriktives Essverhalten nicht nur kurzfristig, sondern auch langfristig positiv beeinflussen kann, während sich für emotionales und externes Essverhalten gemischte Ergebnisse zeigten. Dies legt nahe, dass besonders kognitive Prozesse, welche für restriktives Essverhalten relevant sind, durch eine alleinstehende mHealth-Intervention effektiv verbessert werden können. Demgegenüber könnte die Veränderung emotionalen Essverhaltens womöglich eine intensivere, multimodale oder persönlich begleitete Intervention erfordern.

Im Folgenden werden die zentralen Schwerpunktthemen dieser Dissertation vertiefend diskutiert und in den bestehenden Forschungsstand eingeordnet.

### 3.1 Gewichtsbezogene Stigmatisierung und dysfunktionales Essverhalten

Studie 1 *Weight bias internalization as a mediator between weight stigma and eating behavior: divergent patterns in individuals with normal weight and individuals with overweight and obesity* (Färber et al., submitted) untersuchte den Zusammenhang zwischen gewichtsbezogenen Stigmatisierungserfahrungen, Selbststigmatisierung und zwei Formen des Essverhaltens (emotionales und restriktives Essverhalten) in einer Gruppe von Personen mit Übergewicht und Adipositas sowie in einer Vergleichsgruppe von Personen mit Normalgewicht. Die Mediationsanalysen zeigten, dass gewichtsbezogene Stigmatisierungserfahrungen, unabhängig vom BMI, positiv mit emotionalem Essverhalten zusammenhängen, sofern sich eine Person sich diese Stigmata auch selbst zuschreibt. Interessanterweise zeigte sich ein positiver Zusammenhang zwischen gewichtsbezogenen Stigmatisierungserfahrungen und restriktivem Essverhalten ausschließlich bei Personen mit Normalgewicht. In dieser Gruppe medierte die Selbststigmatisierung zudem diesen Zusammenhang. Restriktives Essverhalten gilt im Gegensatz zu emotionalem Essverhalten als vor einer Gewichtszunahme schützend (Teixeira et al., 2010; van Strien et al., 2009) und könnte bei Personen mit Normalgewicht womöglich kompensatorisch zu emotionalem Essverhalten wirken.

Die Ergebnisse der Studie verdeutlichen, dass sich Stigmatisierungserfahrungen und deren Internalisierung unterschiedlich auf das Essverhalten von Personen mit Übergewicht und Adipositas im Vergleich zu Personen mit Normalgewicht auswirken. Dieser Befund ist von hoher Relevanz für Interventionen zum Gewichtsmanagement, da die Reduktion emotionalen Essverhaltens und der Aufbau eines gesunden restriktiven Essverhaltens häufige Veränderungsziele und wichtige Prädiktoren langfristiger Gewichtsstabilisierung darstellen (Teixeira et al., 2010). Die Betrachtung des Essverhaltens vor dem Hintergrund gewichtsbezogener Stigmatisierung kann dazu beitragen, die höheren Ausprägungen emotionalen Essverhaltens bei Personen mit Übergewicht und Adipositas besser zu verstehen (van Strien, 2018; Vasileiou & Abbott, 2023). Zugleich liefert sie auch einen Erklärungsansatz dafür, weshalb restriktives Essverhaltens für diese Personengruppe eine größere Herausforderung darstellen könnte als für Personen mit Normalgewicht.

## **Bedeutung gewichtsbezogener Stigmatisierung für das Essverhalten**

Wie bereits in Kapitel 1.3 dargelegt, sind Personen mit Übergewicht und Adipositas in verschiedenen Lebensbereichen Stigmatisierung und Diskriminierung ausgesetzt (Puhl & King, 2013; Spahlholz et al., 2016). Doch auch Personen mit Normalgewicht können davon betroffen sein. In Studie 1 gab etwa ein Drittel der Personen mit Normalgewicht an, bereits Erfahrungen mit gewichtsbezogener Stigmatisierung gemacht zu haben, ein Befund, der auch in anderen Studien in ähnlicher Häufigkeit berichtet wird (Prunty et al., 2020).

In westlichen Gesellschaften wird dem Körperbild eine hohe Bedeutung beigemessen, wodurch auch Personen mit Normalgewicht dem gesellschaftlichen Druck ausgesetzt sind, einem bestimmten Idealtypus zu entsprechen (Swami, 2015). Selbst sie können, wenngleich nicht so häufig wie Personen mit Übergewicht oder Adipositas, abwertende Kommentare zu ihrem Gewicht erhalten (Prunty et al., 2020; Spahlholz et al., 2016) und negative Selbstzuschreibungen entwickeln (Pearl & Puhl, 2014). Solche Erfahrungen können zu ähnlichen psychischen Konsequenzen führen wie bei Personen mit Übergewicht und Adipositas, etwa zu depressiven Symptomen, Angstsymptomen oder einer höheren Körperunzufriedenheit und sich auch in dysfunktionalem Essverhalten wie emotionalem Essen oder Essattacken äußern (Pearl & Puhl, 2018).

Für die negativen Auswirkungen von Stigmatisierung auf die psychische Gesundheit, das Körpergewicht und Essverhalten, ist entscheidend, in welchem Ausmaß betroffene Personen das Stigma internalisieren (Pearl et al., 2020; Pearl & Puhl, 2018; Romano et al., 2023). Die Bedeutung der Selbststigmatisierung für dysfunktionales Essverhalten zeigen auch die Ergebnisse einer systematischen Übersichtsarbeit von Pearl und Puhl (2018) sowie einer Meta-Analyse von Romano et al. (2023). In diesen Arbeiten wurden zahlreiche Zusammenhänge zwischen Selbststigmatisierung und verschiedenen Formen dysfunktionalen Essverhaltens gefunden, wie emotionales Essen, Heißhungerattacken und Überessen (Romano et al., 2023) sowie Food Addiction (Pearl & Puhl, 2018). Interessanterweise konnten einige dieser Zusammenhänge unabhängig vom BMI nachgewiesen werden (Pearl & Puhl, 2018). Auch in Studie 1 zeigte sich, dass internalisierte Stigmata den Zusammenhang zwischen Stigmaerfahrungen und emotionalem Essverhalten unabhängig vom Körpergewicht mediieren.

Bei restriktivem Essverhalten zeigte sich in Studie 1 jedoch ein anderes Muster: Stigmaerfahrungen und Selbststigmatisierung hingen nur bei Personen mit Normalgewicht sowohl mit emotionalem als auch mit restriktivem Essverhalten zusammen. Zudem medierte Selbststigmatisierung den positiven Zusammenhang zwischen Stigmaerfahrungen und

restriktivem Essverhalten. Dass bei Personen mit Übergewicht und Adipositas keine Zusammenhänge zwischen Stigmaerfahrungen oder Selbststigmatisierung und restriktivem Essverhalten festgestellt werden konnten, könnte möglicherweise durch die deutlich häufigeren Erfahrungen mit Stress infolge des *Stigmas Übergewicht* sowie durch die nahezu omnipräsente Antizipation zukünftiger Stigmatisierungserfahrungen erklärt werden. Wie bereits in Kapitel 1.3 beschrieben, stellt Stigmatisierungserleben gemäß dem Teufelskreismodell von Tomiyama (2014) einen Stressor dar, der Prozesse und Verhaltensweisen wie emotionales Essen begünstigen kann, was wiederum eine weitere Gewichtszunahme fördern kann. Darüber hinaus führt Stress auf kognitiver Ebene zu einer reduzierten exekutiven Kontrolle sowie zu einer geringeren Selbstregulationsfähigkeit (Tomiyama, 2014, 2019). Da Personen mit Übergewicht und Adipositas Stigmatisierung deutlich häufiger ausgesetzt sind, ist es vorstellbar, dass diesen weniger kognitive Ressourcen für die Aufrechterhaltung eines gesunden restriktiven Essverhaltens zur Verfügung stehen (Major et al., 2012, 2020). Diese Annahme wird durch eine experimentelle Studie von Major et al. (2014) gestützt, in der nach einer Stigmakonfrontation eine geringere Kontrolle über das Essverhalten bei Personen mit Übergewicht und Adipositas, nicht jedoch bei Personen mit Normalgewicht, festgestellt wurde. Erschwerend kommt hinzu, dass Stigmatisierung nicht nur dann zu Stresserleben führt, wenn sie tatsächlich auftritt, sondern auch, wenn sie nur antizipiert oder befürchtet wird (Hunger et al., 2015). Die erwartete Abwertung aufgrund des Körpergewichts kann im Sinne einer Bedrohung der sozialen Identität (englisch: social identity threat) zu chronischem Stresserleben führen und sich negativ auf das Gesundheitsverhalten auswirken, wie zum Beispiel durch das Vermeiden sportlicher Aktivität in der Öffentlichkeit (Hunger et al., 2015; Major et al., 2018; Major & Schmader, 2018; Vartanian & Novak, 2011).

Zusammenfassend lassen sich die Befunde aus Studie 1 zu erhöhtem emotionalem Essverhalten und geringerem restriktiven Essverhalten bei Personen mit Übergewicht und Adipositas im Vergleich zu Personen mit Normalgewicht vor dem Hintergrund der allgegenwärtigen Stigmatisierung womöglich erklären. Zwar kann gewichtsbezogene Stigmatisierung grundsätzlich jede Person unabhängig vom Körpergewicht betreffen, sie trifft jedoch Personen mit tatsächlichem Übergewicht deutlich häufiger (Prunty et al., 2020). Befürchtete oder tatsächliche Stigmaerfahrungen und insbesondere Selbststigmatisierung gehen mit Stresserleben und Selbstabwertung einher (Pearl, 2024) und begünstigen in der Folge dysfunktionales Essverhalten wie vermehrtes emotionales Essverhalten als Copingstrategie sowie verringerte kognitive Kapazitäten für ein langfristig gesundes restriktives Essverhalten (Major et al., 2020; Tomiyama, 2019).

## **Implikationen**

Gewichtsbezogene Stigmatisierung stellt für Personen mit Übergewicht und Adipositas einen allgegenwärtigen Stressor dar und trägt damit ursächlich zur Entwicklung und Aufrechterhaltung dysfunktionalen Essverhaltens, wie emotionalem Essen, sowie einer eingeschränkten Fähigkeit zu restriktivem Essen bei (Major et al., 2020; Tomiyama, 2014, 2019). Entsprechend sollten Interventionen, die auf eine Veränderung dysfunktionalen Essverhaltens abzielen, den Einfluss von Stigmatisierung und Selbststigmatisierung berücksichtigen und gezielt adressieren. Dies kann unter anderen durch Psychoedukation sowie durch die Exploration und Modifikation selbststigmatisierender Überzeugungen erfolgen (Wang et al., 2025). Um eine nachhaltige Reduktion des Stigmas zu erreichen, sind Interventionen auf politischer und gesellschaftlicher Ebene erforderlich. In der Gesellschaft besteht nach wie vor die weit verbreitete Annahme, dass Betroffene selbst die Verantwortung für ihr Gewicht tragen und eine Gewichtsveränderung primär eine Frage individueller Willenskraft und Motivation sei. Dabei werden die komplexen und multifaktoriellen Ursachen von Übergewicht und Adipositas stark vereinfacht dargestellt und zahlreiche obesogene Faktoren vernachlässigt, was zur Aufrechterhaltung des Stigmas beiträgt (Westbury et al., 2023). Ein zentrales Ziel sollte daher sein, diese Annahmen zu verändern und das Wissen über die Ursachen von Übergewicht und Adipositas in der breiten Gesellschaft, beispielsweise über Medien oder den Schulunterricht sowie in spezifischen Berufsgruppen, wie Lehrkräften und medizinischem Fachpersonal, zu verbessern (Rubino et al., 2020). Darüber hinaus bedarf es eines verbesserten rechtlichen Schutzes der Betroffenen vor Diskriminierung. Zu diesem Zweck sollten Stigmatisierung und Diskriminierung gesetzlich sanktioniert werden. In Deutschland wird daher bereits gefordert, die Diskriminierung aufgrund von Übergewicht in das Allgemeine Gleichbehandlungsgesetz aufzunehmen (Antidiskriminierungsstelle des Bundes, 2023).

## 3.2 Gestaltung einer individualisierten psychologischen mHealth-Intervention

Studie 2 *A tailored gender-sensitive mHealth weight loss intervention (I-GENDO): development and process evaluation* (Pape et al., 2022) beschreibt den Entwicklungsprozess der mHealth-App I-GENDO, die Ergebnisse zur individualisierten Zuordnung psychologischer Schwerpunktmodule sowie das Nutzungsverhalten der Teilnehmenden. Die I-GENDO-App stellt eine wissenschaftlich fundierte, psychologische und gendersensible Intervention dar, deren Ziel darin bestand, durch die gezielte Adressierung relevanter psychologischer Faktoren auch dysfunktionales Essverhalten nachhaltig zu verändern. Alle Teilnehmenden bearbeiteten ein Eingangsmodul zur Zielsetzung sowie ein Abschlussmodul zur Rückfallprävention. Darüber hinaus wurden ihnen auf Basis der individuellen Ausprägung psychologischer Variablen jeweils drei von fünf möglichen Modulen für den Interventionszeitraum zugewiesen. Die Module umfassten die Themen Selbstkontrolle, Emotionen, Stressmanagement, Selbstwirksamkeit sowie Umgang mit den Konsequenzen von Übergewicht.

Die Ergebnisse aus Studie 2 zeigen, dass sich sowohl bestimmte Kernthemen beziehungsweise Module identifizieren ließen, die besonders häufig zugeordnet wurden, als auch solche, die zwar nicht für alle Teilnehmenden relevant waren, jedoch für einen nicht zu vernachlässigenden Anteil der Stichprobe eine zentrale Rolle spielten. Darüber hinaus zeigten sich geschlechtsspezifische Unterschiede in der Modulzuweisung, etwa bei der Zuordnung des Moduls *Emotionen*. Insgesamt stützen die Ergebnisse die Annahme, dass eine Individualisierung auf Basis psychologischer Variablen sowie die Berücksichtigung geschlechtsspezifischer Aspekte in der Entwicklung und Durchführung von Interventionen sinnvoll und zielführend sind.

### **Wissenschaftliche Herangehensweise und Auswahl evidenzbasierter Inhalte in der Gestaltung einer mHealth-App**

Die Auswahl der Inhalte von I-GENDO erfolgte auf Basis einer umfassenden Literaturrecherche sowie unter Einbezug bestehender evidenzbasierter Manuale. Zusätzlich wurden Expertenbefragungen und Fokusgruppen mit Betroffenen durchgeführt sowie ein Steuerungsausschuss (Steering Committee) in die Entscheidungsfindung eingebunden. Die Inhalte aller Module wurden gezielt so ausgewählt, dass sie zentrale psychologische Fähigkeiten adressieren, die dem dysfunktionalen Essverhaltens zugrunde liegen. Neben den definierten Oberthemen (Modulen) sind auch die eingesetzten Techniken zur Veränderung des

Erlebens oder Verhaltens, sogenannte Behavior Change Techniques, evidenzbasiert und entsprechen damit allgemeinen Empfehlungen zur Gestaltung psychologischer mHealth-Interventionen (Abraham & Michie, 2008; Dugas et al., 2020). Die Entwicklung der Intervention nach hohen wissenschaftlichen Standards sowie die konsequente Verwendung evidenzbasierter Inhalte sollen sicherstellen, dass Teilnehmende von mHealth-Interventionen tatsächlich profitieren können. Obwohl eine Vielzahl frei verfügbarer Applikationen existieren, die eine Verbesserung des Gesundheitsverhaltens versprechen, mangelt es diesen häufig an wissenschaftlicher Evidenz, was im ungünstigsten Fall sogar zu unerwünschten Effekten führen kann (Albrecht, 2016). Viele Personen mit Übergewicht und Adipositas haben bereits zahlreiche Diätversuche unternommen, teilweise unter Anwendung ungesunder Verhaltensweisen oder Diätmethoden (Haynes et al., 2018). Eine solche Historie wiederholter Gewichtsschwankungen kann für Betroffene belastend sein und sich negativ auf die wahrgenommene Selbstwirksamkeit auswirken (Prill et al., 2021). Entwicklerteams von Interventionen sollten für diese Problematik sensibilisiert sein und konsequent auf evidenzbasierte Methoden, Inhalte und Ansätze zurückgreifen.

Die Inhalte sowie die verwendeten Behavior Change Techniques der I-GENDO-App wurden in Studie 2 ausführlich beschrieben und ermöglichen somit eine transparente Nachvollziehbarkeit der eingesetzten App-Elemente (für eine detaillierte Beschreibung siehe Anhang der Studie 2). Diese transparente Darstellung der Inhalte erleichtert darüber hinaus anderen Forschungsgruppen den wissenschaftlichen Vergleich verschiedener Apps und Inhalte zur Bewertung ihrer Effektivität, was in systematischen Übersichtsarbeiten häufig als Herausforderung beschrieben wird (Metzendorf et al., 2024).

### **Individualisierung ermöglicht die Adressierung relevanter Problembereiche**

Individualisierte Interventionen zur Behandlung von Übergewicht und Adipositas weisen eine höhere Effektivität auf als One-fits-all-Ansätze (Davis et al., 2020; Dugas et al., 2020; Ryan et al., 2019). Insbesondere für langfristige Verhaltensveränderungen sind psychologische Faktoren relevant (Teixeira et al., 2015; Varkevisser et al., 2019). Die I-GENDO-App berücksichtigt beide Aspekte, indem sie psychologische Einflussfaktoren gezielt adressiert und eine individualisierte Zuordnung der Interventionsinhalte ermöglicht. Die Modulzuordnung erfolgte auf Grundlage eines Fragebogens zu Krankheitsannahmen und Kausalattributionen (Glattacker et al., 2009; Moss-Morris et al., 2002).

Das am häufigsten zugeordnete Modul war *Selbstkontrolle*, das über 90% der Teilnehmenden erhalten haben. Dieses Modul beinhaltet Informationen und Übungen zum Umgang mit Heißhunger, zu inhibitorischer Kontrolle sowie zur Reduktion impulsiven Essverhaltens. Eine verringerte Selbstkontrolle begünstigt verschiedene Formen dysfunktionalen Essverhaltens (Arexis et al., 2023; Georgii et al., 2020; Hou et al., 2011; Rose et al., 2018). Entsprechend kann Selbstkontrolle als ein zentraler Aspekt dysfunktionalen Essverhaltens betrachtet werden und gilt zudem als relevanter Prädiktor für die langfristige Aufrechterhaltung gesundheitsbezogener Verhaltensänderungen (Teixeira et al., 2015).

Die Verteilung der übrigen Module zu den Themen Emotionen, Stressmanagement, Selbstwirksamkeit sowie dem Umgang mit den Konsequenzen von Übergewicht verdeutlicht jedoch, dass nicht alle Inhalte für alle Personen gleichermaßen relevant sind. Dies bestätigt, dass One-fits-all-Ansätze den individuellen Bedürfnissen von Interventionsteilnehmenden nicht gerecht werden (Davis et al., 2020; Dugas et al., 2020; Ryan et al., 2019).

Zudem unterstreichen die Ergebnisse die Relevanz geschlechtsspezifischer Aspekte bei der Auswahl von Interventionsinhalten (Cooper et al., 2021). Studie 2 zeigt, dass das Modul *Emotionen* signifikant häufiger Frauen als Männern zugeordnet wurde. Zwar weisen Personen mit Übergewicht und Adipositas insgesamt höhere Ausprägungen emotionalen Essverhaltens auf als Personen mit Normalgewicht (van Strien, 2018; Vasileiou & Abbott, 2023), jedoch berichten Frauen häufiger von emotionalen Ursachen für das Übergewicht (Henning et al., 2024) und weisen ausgeprägteres emotionales Essverhalten auf als Männer (Anversa et al., 2021).

Das Modul zum *Umgang mit den Konsequenzen von Übergewicht*, welches unter anderem das Thema gewichtsbezogene Stigmatisierung adressierte, wurde etwa einem Viertel der Teilnehmenden zugeordnet. Dieses Ergebnis untermauert zum einen die bereits in Studie 1 beschriebene Relevanz gewichtsbezogener Stigmatisierung für das Essverhalten (Tomiya, 2014, 2019). Zum anderen unterstreicht es erneut die Notwendigkeit einer individualisierten Modulzuordnung. Zwar stellt gewichtsbezogene Stigmatisierung für viele Betroffene eine erhebliche Belastung dar, jedoch beschreiben nicht alle Personen diese als zentrale Ursache ihres Essverhaltens oder ihres Körpergewichts.

Zusammenfassend lässt sich festhalten, dass die individualisierte Zuordnung von Interventionsinhalten dazu beitragen kann, relevante psychologische Problembereiche der Teilnehmenden gezielt zu identifizieren und darauf aufbauend passgenaue Interventionsinhalte bereitzustellen. Im Entwicklungsprozess von Interventionen ist dabei eine wissenschaftlich

fundierte Herangehensweise essenziell, um das Risiko unerwünschter Effekte für Betroffene zu minimieren. Die Effektivität einer an individuelle Bedürfnisse angepassten psychologischen mHealth-Intervention für langfristige Veränderungen dysfunktionalen Essverhaltens wird im nachfolgenden Kapitel diskutiert.

### 3.3 Veränderung dysfunktionalen Essverhaltens durch eine psychologische mHealth-Intervention

Forschungsfrage 3 untersuchte, ob eine psychologische Intervention zu einer stabilen Veränderung verschiedener Formen dysfunktionalen Essverhaltens bei Personen mit Übergewicht und Adipositas führen kann.

Studie 3 *Differential effects of the individualized gender-sensitive mHealth intervention I-GENDO on eating styles in individuals with overweight and obesity – a randomized controlled trial* (Seiferth et al., 2023) berichtet die Ergebnisse einer randomisierten kontrollierten Studie, in der die Teilnehmenden die I-GENDO-App über einen Zeitraum von zwölf Wochen nutzten. Das Essverhalten wurde vor Beginn der Intervention, unmittelbar nach Abschluss der Intervention sowie in zwei Follow-Up-Erhebungen erfasst.

Die Intervention zielte auf eine Erhöhung restriktiven sowie auf eine Reduktion emotionalen und externalen Essverhaltens ab. Restriktives Essverhaltens konnte sowohl kurz- als auch langfristig signifikant verbessert werden. Eine Reduktion des externalen Essverhaltens zeigte sich kurzfristig, d.h. direkt nach Ende der Intervention. Langfristige Effekte konnten jedoch ausschließlich bei Frauen, nicht jedoch bei Männern, nachgewiesen werden. Entgegen der Erwartung führte die Intervention kurzfristig zu keiner Reduktion des emotionalen Essverhaltens. Langfristig zeigte sich eine Verbesserung, im Sinne einer Reduktion emotionalen Essverhaltens, lediglich bei Frauen und nur zum ersten Follow-Up-Messzeitpunkt.

#### **Veränderbarkeit dysfunktionaler Essverhaltensstile durch eine psychologische mHealth-Intervention**

Die Ergebnisse der Studie 3 deuten darauf hin, dass die psychologische mHealth-Intervention I-GENDO eine vielversprechende Methode zur Förderung restriktiven Essverhaltens darstellt. Die Veränderung kognitiver Fähigkeiten, die für restriktives Essverhalten erforderlich sind (Bas & Donmez, 2009; Georgii et al., 2020; Linardon, 2018), scheint möglicherweise leichter erreichbar zu sein als die Veränderung emotionaler Prozesse, die emotionalem Essen zugrunde liegen (Arexis et al., 2023; Gianini et al., 2013; Sutton et al., 2022).

Restriktives Essverhalten gilt als Prädiktor für Gewichtsstabilisierung und langfristige Erfolge in der Gewichtsreduktion (James et al., 2018; Teixeira et al., 2010, 2015). Entsprechend stellt der Aufbau eines gesunden Ausmaßes restriktiven Essverhaltens ein häufiges Ziel verhaltensbezogener Interventionen dar. Darüber hinaus wird restriktives Essverhalten als

protektiver Faktor gegenüber einer Gewichtszunahme diskutiert, selbst wenn weitere dysfunktionale Essverhaltensweisen wie Überessen vorliegen, die häufig mit einer Gewichtszunahme assoziiert sind (van Strien et al., 2009). Ein gewisses Maß an restriktivem Essverhalten kann somit als funktionaler Gegenspieler emotionalen Essverhaltens verstanden werden, wie bereits in den Ergebnissen der Studie 1 zu Auswirkungen von gewichtsbezogener Stigmatisierung auf Essverhalten, dargestellt wurde (vgl. Kapitel 3.1; Färber et al., submitted).

Die mHealth-App I-GENDO konnte restriktives Essverhalten sowohl kurz- als auch langfristig signifikant verbessern. Im Vergleich zu einer inhaltlich ähnlichen mHealth-Studie im Postpartum-Zeitraum erzielte I-GENDO sogar günstigere Ergebnisse, da die Verbesserungen restriktiven Essverhaltens nicht nur kurzfristig, sondern auch langfristig aufrechterhalten werden konnten (Bijlholt et al., 2021). Zudem wurde dieser Effekt in der I-GENDO-Intervention ausschließlich durch eine selbstgesteuerte stand-alone-App erzielt, während die Intervention von Bijlholt et al. (2021) zusätzlich vier persönliche Beratungsgespräche umfasste. Die I-GENDO-App integrierte zahlreiche evidenzbasierte Interventionselemente zur Förderung von Fähigkeiten wie Selbstkontrolle und Selbstwirksamkeit, die für ein gesundes Maß restriktiven Essverhaltens erforderlich sind (Bas & Donmez, 2009; Georgii et al., 2020; Linardon, 2018). Das beobachtete langfristig verbesserte restriktive Essverhalten spricht somit für die besondere Eignung von mHealth-Interventionen zur Beeinflussung kognitiver Prozesse, die restriktivem Essverhalten zugrunde liegen (Bas & Donmez, 2009; Georgii et al., 2020; Linardon, 2018).

Grenzen der Wirksamkeit rein appbasierter (stand-alone) mHealth-Interventionen zeigen sich hingegen bei anderen Formen dysfunktionalen Essverhaltens, wie externalem oder emotionalem Essverhalten. In Studie 3 konnte eine Reduktion externalen Essverhaltens ausschließlich bei Frauen nachgewiesen werden. Dies legt nahe, dass Veränderungen durch mHealth-Interventionen zwar grundsätzlich möglich sind, jedoch geschlechtsspezifische Unterschiede stärker berücksichtigt werden müssen. Frauen sprechen im Vergleich zu Männern stärker auf Achtsamkeitsinterventionen an (Rojiani et al., 2017) und profitieren insgesamt häufiger von entsprechenden Ansätzen (Katz & Toner, 2013). Zudem verfügen Frauen häufiger über Vorerfahrungen mit Maßnahmen zur Gewichtsreduktion (Tsai et al., 2015). Männer hingegen zeigen eine geringere Bereitschaft zur Teilnahme an Interventionen zur Behandlung von Übergewicht (Cooper et al., 2021) und bevorzugen bei der Nutzung gesundheitsbezogener Apps häufiger Fitness-Apps (Bol et al., 2018). Darüber hinaus unterscheiden sich Copingstrategien, Hilfesuchverhalten sowie Erwartungen an psychologische Interventionen

zwischen den Geschlechtern (Liddon et al., 2018). Vor diesem Hintergrund ist anzunehmen, dass die Inhalte der I-GENDO-App trotz Bemühungen nicht optimal auf die Bedürfnisse männlicher Teilnehmer zugeschnitten waren. Für eine wirksame Reduktion externalen Essverhaltens bei Männern könnten alternative oder ergänzende Ansätze jenseits achtsamkeitsbasierter Methoden erforderlich sein.

Bezüglich des emotionalen Essverhaltens zeigte sich in Studie 3 ebenfalls keine stabile Veränderung, im Sinne einer langfristigen Reduktion. Dieses Ergebnis war zunächst überraschend, da die I-GENDO-App zahlreiche Elemente zur Emotionsregulation enthielt, deren Wirksamkeit in face-to-face-Interventionen bereits belegt ist (Smith et al., 2023). Emotionales Essverhalten wird maßgeblich durch Emotionsregulationsfähigkeiten beeinflusst (Gianini et al., 2013), deren Veränderbarkeit jedoch auch in anderen appbasierten Interventionen bislang uneinheitlich belegt ist (Eisenstadt et al., 2021). So berichten vergleichbare mHealth-Studien ähnliche Befunde wie jene aus der I-GENDO-Intervention und weisen darauf hin, dass restriktives Essverhalten leichter veränderbar ist als emotionales Essverhalten (Bijlholt et al., 2021). Auch Studien aus weiteren Anwendungsfeldern, wie Stress oder Depression, zeigen, dass zur Veränderung emotionaler Prozesse womöglich kombinierte Ansätze aus mHealth und persönlichen Unterstützungskontakten wirksamer sind als mHealth-Interventionen als alleinige Maßnahme (Borjalilu et al., 2019; Duarte-Díaz et al., 2023).

Für die Behandlung emotionalen Essverhaltens bei Übergewicht und Adipositas lässt sich daher schlussfolgern, dass alleinstehende mHealth-Interventionen an ihre Grenzen stoßen. Eine aktuelle systematische Übersichtsarbeit und Metaanalyse empfiehlt mHealth-Ansätze generell eher als ergänzendes Element zu klassischen Interventionen und weniger als primäre Behandlungsstrategie (Chiavarini et al., 2025). Die Ergebnisse der Studie 3 bekräftigen diese Einschätzung für die Veränderung emotionalen Essverhaltens. Als eigenständige Intervention zur Verbesserung restriktiven Essverhalten erweist sich der mHealth-Ansatz hingegen als gut geeignet.

## **Auswirkungen der I-GENDO-Intervention auf das Körpergewicht**

Die Annahme, dass eine Veränderung dysfunktionalen Essverhaltens indirekt zu einer langfristigen Reduktion des BMI führen kann, konnte in Studie 3 lediglich für Männer bestätigt werden. Dabei handelte es sich jedoch um einen Gewichtsverlust, der als klinisch nicht relevant einzustufen ist, da weniger als 5% des Ausgangsgewichts reduziert wurden (Ryan & Yockey, 2017). Dieses Ergebnis ist vor dem Hintergrund des gewählten Interventionsansatzes nicht überraschend. Die I-GENDO-Intervention verfolgte nicht primär das Ziel einer Gewichtsreduktion, enthielt keine konkreten Vorgaben zu Kalorienzufuhr oder Bewegungszielen und betrachtete den BMI lediglich als sekundären Outcome. Aktuelle systematische Übersichtsarbeiten und Meta-Studien zeigen zudem, dass selbst Interventionen mit konkreten Vorgaben zu Ernährung und körperlicher Aktivität bislang keine langfristig klinisch relevante BMI-Reduktion durch mHealth allein erzielen konnten. Dies gilt sowohl für webbasierte Interventionen im Allgemeinen (Beleigoli et al., 2019) als auch für mHealth-Apps, die explizit auf Bewegungs- und Kalorienmonitoring abzielen (Chew et al., 2022; Park et al., 2019). Entsprechend können mHealth-Interventionen derzeit nur als ergänzende Maßnahme zu klassischen Behandlungsansätzen empfohlen werden (Chiavarini et al., 2025). Vor diesem Hintergrund ist hervorzuheben, dass sich in Studie 3 dennoch für Männer eine langfristig statistisch signifikante Reduktion des BMI zeigte. Dies ist insofern bemerkenswert, da selbst multimodale klassische Lifestyle-Interventionen zwar kurzfristig wirksam sind, jedoch häufig keine stabilen langfristigen Effekte erzielen (Webb & Wadden, 2017).

Der Ansatz von I-GENDO, in der Behandlung von Übergewicht und Adipositas den Fokus stärker auf individuelle psychologische Problembereiche und weniger auf das Körpergewicht beziehungsweise eine Gewichtsabnahme als primäres Wirksamkeitskriterium zu legen, spiegelt einen grundlegenden Haltungswechsel in der Adipositas therapie wider. Zunehmend wird gefordert, Interventionen primär auf eine generelle Verbesserung gesundheitsbezogenen Verhaltens auszurichten, etwa im Sinne gewichtsunabhängiger und gewichtsneutraler Ansätze (Gaesser & Angadi, 2021; Mauldin et al., 2022). Die Annahme, dass eine reine Gewichtsreduktion die zentrale Lösung darstellt, greift zu kurz, trägt zur Simplifizierung des komplexen Zusammenspiels physiologischer, psychologischer und sozialer Einflussfaktoren auf das Körpergewicht bei und hält dadurch auch das Stigma von Übergewicht und Adipositas aufrecht (Westbury et al., 2023).

### 3.4 Limitationen und Stärken

Die Ergebnisse der vorliegenden Dissertation sind unter der Berücksichtigung mehrerer Limitationen zu interpretieren. Studie 1 sowie die Analysen zu gewichtsbezogener Stigmatisierung basieren auf querschnittlichen Daten, sodass keine kausalen Schlussfolgerungen über den Zusammenhang zwischen Stigmatisierung und Essverhalten gezogen werden können. Die Befunde liefern zwar Hinweise auf relevante Zusammenhänge, diese sollten jedoch in zukünftigen Längsschnittstudien weiter untersucht und abgesichert werden. Im Hinblick auf die Entwicklung der I-GENDO-App ist zudem zu beachten, dass sich ein potenzieller Einflussfaktor aus der personellen Zusammensetzung des Entwicklerteams ergibt, das überwiegend weiblich war. Trotz der bewussten Berücksichtigung geschlechtsspezifischer Aspekte in der Planung und Umsetzung der Intervention kann daher nicht ausgeschlossen werden, dass die Inhalte in gewissem Maße einem Gender Bias unterliegen und die Ansprechbarkeit für Männer und Frauen unterschiedlich beeinflusst haben. Ein weiterer limitierender Faktor besteht darin, dass der Erhebungszeitraum von Studie 3, der Längsschnittstudie zur I-GENDO-Intervention, in den Zeitraum der Coronavirus-Pandemie fiel, deren Auswirkungen auf die psychosoziale Belastung und gesundheitsbezogenen Verhalten, einschließlich des Essverhaltens, nicht vollständig kontrollierbar waren und die Ergebnisse beeinflusst haben könnten. Darüber hinaus lassen sich die Effekte der Intervention ausschließlich auf die Gesamtintervention, nicht aber auf einzelne Elemente, wie einzelne Interventionsmodule, zurückführen. Dies stellt ein bekanntes methodisches Problem dar, insbesondere im Hinblick auf die Vergleichbarkeit verschiedener digitaler Interventionen mit heterogenen Inhalten (Metzendorf et al., 2024). Schließlich ist zu berücksichtigen, dass I-GENDO gezielt für Personen mit Übergewicht und Adipositas ohne komorbide Essstörungen konzipiert wurde, was die Generalisierbarkeit der Ergebnisse einschränkt. Für Personen mit komorbiden Essstörungen sind spezialisierte psychotherapeutische Behandlungsangebote vorrangig indiziert.

Trotz dieser Limitationen weist die vorliegende Arbeit mehrere inhaltliche und methodische Stärken auf. Hervorzuheben ist insbesondere das randomisierte kontrollierte Längsschnittdesign mit Follow-Up-Erhebungen bis 15 Monate nach Interventionsbeginn, das belastbare Aussagen zur Wirksamkeit und Nachhaltigkeit der Intervention ermöglicht. Die Entwicklung und Evaluation der Intervention erfolgten konsequent auf evidenzbasierter Grundlage. Ein innovatives Element der Arbeit ist der Fokus auf zugrunde liegende individuelle psychologische Faktoren dysfunktionalen Essverhaltens. Dieser Ansatz stellt eine bedeutende

Erweiterung klassischer Interventionen dar, die häufig primär auf Gewichtsreduktion ausgerichtet sind und oftmals einem One-fits-all-Ansatz folgen. Die Ergebnisse der Dissertation zeigen, dass ein psychologisch fundierter und individualisierter Ansatz praktisch wirksam ist und zu nachhaltigen Veränderungen dysfunktionalen Essverhaltens führen kann – selbst in Form einer mHealth-App. Eine weitere Stärke der Arbeit liegt in der Untersuchung gewichtsbezogener Stigmatisierung, die den Blick über individuelle Verhaltensfaktoren hinaus erweitert und soziale sowie gesellschaftliche Einflussgrößen mit einbezieht. Die zusätzliche Rekrutierung einer Stichprobe mit Personen mit Normalgewicht ermöglichte dabei einen differenzierten Vergleich und trägt zu einem umfassenderen Verständnis stigmabezogener Prozesse bei.

### 3.5 Fazit und Ausblick

Die Ergebnisse der vorliegenden Dissertation zeigen, dass dysfunktionales Essverhaltens bei Personen mit Übergewicht und Adipositas durch eine individualisierte, psychologische mHealth-Intervention gezielt beeinflusst werden kann. Insbesondere restriktives Essverhalten ließ sich auch langfristig positiv verändern, während emotionales und externes Essverhalten offenbar intensivere oder persönlich begleitete Behandlungsansätze erfordert. Darüber hinaus verdeutlichen die Befunde die zentrale Bedeutung psychosozialer Einflussfaktoren, wie gewichtsbezogene Stigmatisierung, für das Essverhalten. Dysfunktionales Essverhalten ist somit nicht ausschließlich als individuelles Verhaltensproblem zu verstehen, sondern entsteht im Zusammenspiel psychologischer, sozialer und gesellschaftlicher Rahmenbedingungen. Entsprechend sollten Interventionen dieser Komplexität Rechnung tragen.

Auf Grundlage der in dieser Arbeit dargestellten Befunde erscheint es sinnvoll, die Weiterentwicklung kombinierter Behandlungsansätze weiterzuverfolgen, die digitale Interventionen mit persönlichen Beratungs- oder Therapieangeboten, im Sinne von Blended-Counselling-Ansätzen, verbinden. Solche Konzepte könnten besonders bei komplexeren Ausprägungen dysfunktionalen Essverhaltens, wie emotionalem Essen, nachhaltigere Veränderungen fördern. Darüber hinaus könnten zukünftige mHealth-Interventionen von einer stärkeren Individualisierung profitieren. Der Einsatz KI-gestützter Elemente bietet hierbei das Potenzial, Inhalte stärker an individuelle psychologische Merkmale, Nutzungsverhalten sowie persönliche Veränderungsverläufe anzupassen. Ein weiterer relevanter Entwicklungsbereich ergibt sich aus der Bedeutung gewichtsbezogener Stigmatisierung und Selbststigmatisierung. Neben individualbezogenen Interventionen erscheinen vor diesem Hintergrund auch gesellschaftliche und strukturelle Maßnahmen, wie Aufklärungs- und Sensibilisierungsinitiativen, erforderlich, um Stigmatisierungsprozesse langfristig zu reduzieren. Methodisch erscheint es für zukünftige Studien sinnvoll, ergänzend gewichtsneutrale Indikatoren körperlicher und mentaler Gesundheit zu berücksichtigen, um gesundheitliche Veränderungen auch jenseits reiner Gewichtsparameter erfassen zu können.

Insgesamt unterstreicht die vorliegende Arbeit das Potenzial digitaler Interventionen, eine niedrigschwellige und alltagsnahe Unterstützung zu bieten, macht jedoch zugleich deutlich, dass für nachhaltige Veränderungen komplexer Essverhaltensmuster eine Kombination digitaler und persönlicher Ansätze sinnvoll erscheint. Diese Dissertation liefert damit wichtige Impulse für die Entwicklung evidenzbasierter mHealth-Interventionen zur Förderung eines gesunden und funktionalen Essverhaltens bei Personen mit Übergewicht und Adipositas.

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