

Prevention of eating disorders—Efficacy and cost-benefit of a school-based program (“MaiStep”) in a randomized controlled trial (RCT)

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Abstract

Objective: Given the severity of eating disorders, effective and easily implementable prevention programs which reduce incidence rates and in addition have health-economic benefits are essential. The majority of research on prevention programs focuses on questionnaire-based efficacy or the reduction of eating disorder symptoms while neglecting the health-economic perspective. By contrast, the present study focuses on both an efficacy analysis considering diagnostic criteria (DSM-5) and on evaluating the cost-benefit of a universal prevention program for eating disorders (“MaiStep”).

Method: A three-arm randomized controlled trial with baseline, posttreatment and 12-month follow-up was conducted with 1,654 adolescents ($M = 13.35$, $SD = 0.76$), comprising two intervention groups (MaiStep delivered by psychologists or teachers, IG-T) and an active control group (ACG). The primary outcome was DSM-5 eating disorder diagnosis measured with the SIAB-S. Furthermore, the costs of the prevention program and the savings in health care costs were calculated.

Results: A significant difference in eating disorder diagnosis was found between the IG-T and the ACG for posttreatment ($\chi^2(1 = 7.352, p = .007)$, Relative Risk (RR) = .53 and 12-month follow-up ($\chi^2(1 = 5.203, p = .023)$, RR = .61. MaiStep proved to be cost-effective ($t_{cbr} = 6.75$), saving about 560,000 € (standardized per 1,000 students = 601,388.19 €).

Discussion: Universal prevention can both reduce incidence rates of eating disorders and be cost-beneficial for health care systems. Future research should analyze prevention programs regarding efficacy and cost-benefit to enable comparability and derive guidelines for political decision-makers.

Trial registration number: MaiStep is registered at the German Clinical Trials Register (DRKS00005050).

KEYWORDS

anorexia nervosa, bulimia nervosa, cost-benefit, DSM-5, eating disorders, efficacy, health economics, school-based programs, universal prevention

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1 | INTRODUCTION

Eating disorders such as anorexia nervosa (AN), bulimia nervosa (BN), or binge-eating disorder (BED) are severe mental disorders that particularly affect a very young population of children and adolescents (Jaite, Hoffmann, Glaeske, & Bachmann, 2013). While prevalence rates for full-syndrome eating disorders (AN, BN, BED) are low compared to other mental illnesses (Jacobi et al., 2014; Wittchen et al., 2011; Wittchen, Nelson, & Lachner, 1998), rates for subthreshold eating disorders or other specified feeding or eating disorder (OSFED) are higher (Ernst, Bürger, & Hammerle, 2017; Mitchison et al., 2020; Stice, Marti, & Rohde, 2013; Stice, Marti, Shaw, & Jaconis, 2009). Eating disorders are difficult to treat, tend to take a chronic course, and are often associated with serious physical complications and high morbidity and mortality rates (Arcelus, Mitchell, Wales, & Nielsen, 2011; Fichter, Quadflieg, Crosby, & Koch, 2017; Herpertz-Dahlmann et al., 2018; Keel, Brown, Holm-Denoma, & Bodell, 2011; Smink, van Hoeken, & Hoek, 2012). AN and BN combined are the 12th leading cause of disability-adjusted life years (DALYS) in female adolescents aged 15–19 years in high-income countries (Erskine, Whiteford, & Pike, 2016). All of these aspects are associated with high socioeconomic costs for health care systems (Bode, Gotz von Olenhusen, Wunsch, Kliem, & Kroger, 2017).

Consequently, effective prevention programs to reduce incidence rates of eating disorders (Herpertz-Dahlmann et al., 2018) are needed. Many prevention programs focus only on risk groups, for example, girls, or address already afflicted persons utilizing secondary prevention (Pickhardt, Adametz, Richter, Strauss, & Berger, 2019; Pratt & Woolfenden, 2002; Watson et al., 2016). Moreover, both targeted and universal prevention programs often assess risk factors for the development of eating disorders using self-report questionnaires, without directly assessing eating disorders in line with the DSM-5 (Berger, Joseph, Sowa, & Strauß, 2007; Pickhardt et al., 2019; Wilksch, 2014). Only a small number of studies have focused on incidence rates in order to measure the efficacy of prevention programs (Pickhardt et al., 2019; Pratt & Woolfenden, 2002; Stice, Rohde, Gau, & Shaw, 2012). To overcome these methodological limitations, the universal prevention program “Mainz School Training of Eating Disorder Prevention” (MaiStep) was designed to address a healthy population of school students including all genders. Further information on the conceptualization and background of MaiStep can be found in Buerger et al. (2019).

Studies examining prevention programs in terms of economic efficiency are rare (Akers, Rohde, Stice, Butryn, & Shaw, 2017; Le et al., 2017; Wang, Nichols, & Austin, 2011). Most of these studies focus on cost-effectiveness, relating the costs of a program to a restricted number of key outcomes, for example, prevented eating disorder cases or reduction in DALYS or costs for the health care sector (Akers et al., 2017; Le, Barendregt, et al., 2017; Wang et al., 2011). In contrast, cost-benefit analysis go a step further in comparing all costs and benefits in direct monetary units and currencies. Therefore, cost-benefit analysis can assist decision-makers in their choice of whether or not to implement a program (Cellini & Kee, 2015).

Given the challenging and protracted treatments, eating disorders result in immense costs for health care systems (Ágh et al., 2016; Bode et al., 2017; Krauth, Buser, & Vogel, 2002; Stuhldreher et al., 2015). A report evaluating overall health care costs across approximately 30 European countries in 2010 found that eating disorders are associated with the highest proportion of direct health care costs (72%, amounting to 827 million Euros) among mental and neurological disorders of the brain (Gustavsson et al., 2011; Olesen, Gustavsson, Svensson, Wittchen, & Jonsson, 2012). Annual health care costs differ between countries due to different health care systems and different insurance coverage models (Ágh et al., 2016). Based on cost-of-illness studies for AN, BN, BED and eating disorders not otherwise specified (EDNOS), Stuhldreher et al. (2012) calculated annual costs per patient of between 1,288 and 8,042 US\$ in 2008. Treatment costs for AN and BN are comparable to treatment costs of other highly cost-intensive mental disorders like schizophrenia (Striegel Weissman & Rosselli, 2017). In a German study analyzing health care use in patients diagnosed with AN or subsyndromal AN, 3-month costs per patient amounted to about 5,866 €, which is almost four times higher than the costs for the average population of Germany (Stuhldreher et al., 2015). Even patients diagnosed with EDNOS, as a DSM-IV diagnosis, do not differ significantly from those with full-syndrome AN or BN in terms of functional impairment and health care costs (Keel et al., 2011; Mitchell et al., 2009; Stice et al., 2009; Striegel-Moore et al., 2008).

1.1 | Aims and hypotheses of the study

To address the aforementioned limitations concerning eating disorder prevention programs, the first objective of this study was to examine the efficacy of a universal prevention program (MaiStep) based on DSM-5 diagnosis (Falkai et al., 2018). We expected to find significantly fewer eating disorder cases in the MaiStep group compared to an active control group (ACG) at postintervention (hypothesis 1a) and at a 12-month follow-up (hypothesis 1b). The second objective was to evaluate the prevention program (MaiStep) in terms of the cost-benefit. Specifically, we expected the implementation of MaiStep to be less expensive than the direct and indirect costs for expected eating disorder cases (hypothesis 2).

2 | METHODS

2.1 | Procedure and study design

The study was approved by the local independent ethics committee and the local commissioner for data protection. The study design consisted of a randomized controlled trial with three arms. In agreement with the Ministry of Education in Rhineland-Palatinate, Germany, 21 schools were randomly selected and informed about the study. Of these schools, 17 wished to participate, and nine schools were randomly included in the study, representing all types of secondary

schools in Rhineland-Palatinate. Due to the requirements of the Ministry of Education, the nine schools were randomized to one of the three groups on a school-wise basis. The two intervention groups and the ACG were assessed at baseline, posttreatment and 12-month follow-up.

MaiStep was implemented by psychologists of the Department of Child and Adolescent Psychiatry and Psychotherapy, University Medical Centre of the Johannes Gutenberg University Mainz in intervention group 1 (IG 1) and by trained teachers in intervention group 2 (IG 2). To ensure adequate delivery of the MaiStep training, all teachers attended a 2-day workshop prior to the study, including information about eating disorders and instructions on implementing the training. A specially developed accompanying manual was used to further standardize and guarantee the adherence to the program. For the present analysis, the two intervention groups, IG 1 and IG 2, were pooled together and summarized for further analysis under IG-T. Both intervention groups received the same training and were equally effective (no difference in students fulfilling criteria for any ED; T1: IG 1:13 (2.8%), IG 2:16 (3.3%), $\chi^2(1) = .416, p = .519$; T2: IG 1:16 (3.3%), IG 2:20 (4.3%), $\chi^2(1) = .590, p = .442$).

The third group was an ACG in which teachers conducted a universal prevention program for stress prevention (a team-based prevention program called PIT, “Praevention im Team”), which was recommended by the Federal Center for Health Education. This design was chosen to exclude unspecific effects.

2.2 | Intervention

To ensure the best possible incorporation into school curricula, MaiStep includes five 90-min units (corresponding to two regular school lessons) delivered at weekly intervals, focusing on topics that play a role in the development of eating disorders. The didactic methods are interactive, consisting of skills coaching including experience-based approaches, group discussions, video elements, role plays and homework. MaiStep is conducted by a tandem of a male and a female coach, to ensure that certain units (e.g., body-related issues) can be presented separately for boys and girls. A detailed overview of the program's contents, development and guarantee of implementation adherence have been previously provided by Buerger et al. (2019).

2.3 | Participants

For the informed consent procedure, initially, all students and caregivers in grades 7 and 8 were provided with written information about the study and the program. Specially arranged evening parent meetings were then used to further inform caregivers, allow for questions, and for parents to provide written informed consent. Subsequently, students were verbally informed and asked to provide written informed consent. Out of 1,775 informed students, $N = 1,654$ students (seventh and eighth grades, 47.2% male, 52.8% female) and

their caregivers gave written informed consent. Data were collected at baseline, posttreatment and 12-month follow-up. The mean age was 13.4 years ($SD = 0.76$); 55.6% attended the seventh grade and 44.4% the eighth grade. The participants' average body mass index ($BMI = \text{kg}/\text{m}^2$) was 20.00 ($SD = 3.46$), which corresponds to a BMI percentile of 55.25 according to the data of Kromeyer-Hauschild et al. (2001). At baseline, data were collected from 972 participants of the IG-T (58.8%) and 682 participants (41.2%) of the ACG. No significant differences at baseline were found between the groups. Possible distortions due to cluster randomization were analyzed using a Chi-square test for eating disorder cases in both groups versus clusters (all schools). No differences were detected.

2.4 | Measures

Besides demographic information (school, age), students received a large set of different self-report questionnaires for eating disorder pathology, body dissatisfaction, eating disorder risk factors and general health. Body weight and height were measured with audited scales and stadiometers. For results on these parameters, please refer to Buerger et al. (2019). In the present study, we focused on the Structured Interview for Anorexic and Bulimic Syndromes – self-report (SIAB-S), which directly assesses the criteria for eating disorders (Fichter & Quadflieg, 1999). The SIAB-S shows high correlations with the SIAB-Expert and the Eating Disorder Examination (EDE) expert interview and substantial convergent and discriminant validity with other scales such as the EDI-2 and the Three-Factor Eating Questionnaire, and measures of psychopathology such as the BDI and SCL-90-R (Fichter & Quadflieg, 1999). The SIAB-S has shown good internal consistency (Cronbach's $\alpha = .74$ to $.92$; Fichter & Quadflieg, 1999), and the sensitivity and specificity for detecting partial and full-syndrome eating disorders are within an acceptable range using a sample of 377 inpatients with eating disorders and 111 healthy participants (Fichter & Quadflieg, 2000). In this sample, an excellent overall Cronbach's α of $.91$ was found (George & Mallery, 2010). According to the manual, 23 items corresponding to diagnostic criteria of the DSM-5 (Falkai et al., 2018) of the full questionnaire augmented with weight and height measurements were used for the analysis. The SIAB-S was used to categorize students at all three measurement points. Students defined as “non-healthy” fulfilled criteria for DSM-5 (Falkai et al., 2018) threshold eating disorders or “Other Specified Feeding and Eating Disorders” (OSFED), in contrast to the healthy subsample. Further information about the applied criteria can be found in Ernst et al. (2017) and Hammerle, Huss, Ernst, and Bürger (2016).

2.5 | Calculation of costs

For the implementation of MaiStep with 907 students, the total calculated costs per student amounted to 107.20 €. Total expenditure stems from two areas: MaiStep organizational costs and salary costs

for teachers (Table 1). MaiStep organizational costs comprised expenses for human resources and equipment, administration, delivery of training workshops for teachers throughout Germany by qualified psychologists, travel expenses, and material needed to conduct MaiStep, such as posters or accompanying booklets. To also account for indirect costs stemming from absence of teachers from the regular school routine while attending the MaiStep training workshops, we included their salary costs for the duration of the workshops. The second area of expenses comprises salary costs for teachers conducting MaiStep. Since 2012, a total of 22,124 students have participated in MaiStep in their classes, with an average class size of 25 and two teachers performing 10 school lessons. All salary costs for teachers were calculated on the basis of the German mean gross salary for teachers in 2020—averaged over all Federal states of Germany—from newly qualified to highly experienced (26 years as a teacher) high school teachers (Holzapfel & Viebrock, 2020). One teaching lesson was thus calculated at 62.81 €, resulting in aggregate costs of 107.20 € per student attending MaiStep. Except in the initial trial, MaiStep has been exclusively delivered by teachers in Germany. Thus, in order to get as close as possible to the actual implementation costs, we used the expenses of the teacher-delivered group as a basis for the cost calculation.

TABLE 1 Prevention and health care costs

Item	Value
Overall MaiStep costs per student	107.20 €
MaiStep organizational costs per student	56.95 €
Teacher salary costs per student	50.25 €
Average illness costs per eating disorder case	27,349.42 €
One year illness costs AN	7,127.59 €
One year illness cost BN/BED/OSFED	1,748.28 €
Average illness duration AN	7 years
Average illness duration BN/BED/OSFED	8 years
Average point prevalence of adolescents for AN	0.25%
Average point prevalence of adolescents for BN	2.15%
Average point prevalence of adolescents for BED	0.75%
Average point prevalence of adolescents for OSFED	4.05%

Abbreviations: AN, anorexia nervosa; BED, binge-eating disorder; BN, bulimia nervosa; OSFED, other specified feeding or eating disorder.

Notes: MaiStep organizational costs per student includes organization and communication with schools and investor, performance of training workshops in qualifying teachers, travel expenses and material needed to perform MaiStep. Teacher costs per student includes 1-day workshop (8 h) and performance of MaiStep in class (two teachers, 10 h, class size: 25). Average illness costs per eating disorder case include duration of illness and the relative prevalence of eating disorders (AN, BN, BED, OSFED).

Eating disorders are associated with serious physical limitations, which require treatment from diverse medical disciplines, such as cardiology, dentistry, and orthopedics, or can even lead to treatment on intensive care units, ultimately resulting in high rates of unemployment among patients with eating disorders (Striegel-Moore et al., 2008; Stuhldreher et al., 2015; Wentz, Gillberg, Anckarsäter, Gillberg, & Råstam, 2009). For the purpose of the present study, we conducted a literature search, considered information from German health insurance companies, and compared several cost-of-illness studies (Ágh et al., 2016; Bode et al., 2017; Gustavsson et al., 2011; Olesen et al., 2012; Stuhldreher et al., 2012; Stuhldreher et al., 2015). As a basis for our calculation of health care costs, we adopted the annual health care costs reported by Krauth et al. (2002). The authors included a wide range of direct and indirect cost aspects in their analysis, for example, inpatient treatment, pharmaceuticals, rehabilitation measures, costs due to inability to work or premature death. However, while the analysis reported costs for AN (5,300.00 € per patient and year) and BN (1,300.00 € per patient and year), it did not report costs for BED and OSFED. Following a conservative approach, we calculated costs for BED and OSFED on the basis of those associated with BN in the analysis by Krauth et al. (2002), as BED and OSFED are also classified as highly cost-intensive disorders (Ágh et al., 2016; Stuhldreher et al., 2012).

We adjusted the health care costs from Krauth et al. (2002) according to the rate of inflation (€ 2019, Statistisches Bundesamt [Destatis], 2020) and projected them for the average illness duration: AN 7 years, BN/BED/OSFED 8 years (Byrne, Fursland, Allen, & Watson, 2011; de la Rie, Noordenbos, & van Furth, 2005; Fichter et al., 2017; Fichter, Quadflieg, & Hedlund, 2006; Keski-Rahkonen et al., 2007; Pohjolainen et al., 2010). To avoid an overemphasis on AN, the average costs of an eating disorder case were calculated based on the likelihood of occurrence. Based on the literature on point prevalence rates in adolescents, mean values from three studies were calculated: AN: 0.25%; BN: 2.15%; BED: 0.73%; OSFED: 4.05% (Allen, Byrne, Oddy, & Crosby, 2013; Flament et al., 2015; Mitchison et al., 2020). The global mean value for eating disorder expenses was calculated at 27,349.42 €. A detailed overview is provided in Table 1.

2.6 | Statistical analysis

Statistical analysis was performed using IBM SPSS Statistics version 24. The level of statistical significance was set at $p < .05$ for all tests. Missing values were imputed using the last-observation-carried-forward method, leading to an intent-to-treat dataset (Tabachnik, Fidell, & Ullmann, 2007). The total study sample (N_1) was divided at baseline into a healthy subsample (n_2) and a sample fulfilling criteria for any eating disorder or OSFED according to the DSM-5 (n_3). In order to focus on the preventive effect, further analysis were only conducted for the healthy subsample (n_2). Students who met the criteria for any eating disorder were informed about therapy options and were excluded from the analysis but still participated in MaiStep to avoid stigmatization. We

used McNemar's χ^2 test to measure statistical independence between healthy students of the ACG and the MaiStep group (IG-T; Bortz & Schuster, 2010). Relative risk (RR) and odds ratios (OR) were calculated for better comparison (Bortz & Lienert, 2008). RR describes the likelihood of the occurrence of an event (e.g., ED) compared to a reference group, whereas the OR represents the odds that an event (e.g., ED) will occur under a specific condition compared to the odds of the occurrence in the absence of the condition (Andrade, 2015). To analyze the importance of MaiStep from a health-economic perspective, we compared the costs of eating disorders versus the costs of conducting MaiStep in order to assess whether the program benefits outweigh the program costs. The absolute risk of the ACG in developing an ED was used as a basis for cost-benefit analysis. We further calculated 95% CI to provide information on the variation. For a comparative analysis, we

calculated the benefit-cost ratio as the ratio of benefits divided by costs in monetary units (Kee, 2004; Welsh, Farrington, & Gower, 2015). A cost-benefit ratio greater than one indicates an economically beneficial program (Cellini & Kee, 2015).

3 | RESULTS

3.1 | Study sample

Of the 1,654 students taking part in the study, 122 students were categorized at baseline as nonhealthy, as they fulfilled the DSM-5 criteria for an eating disorder or OSFED. These students were excluded from further analysis. Of the healthy subsample of 1,532

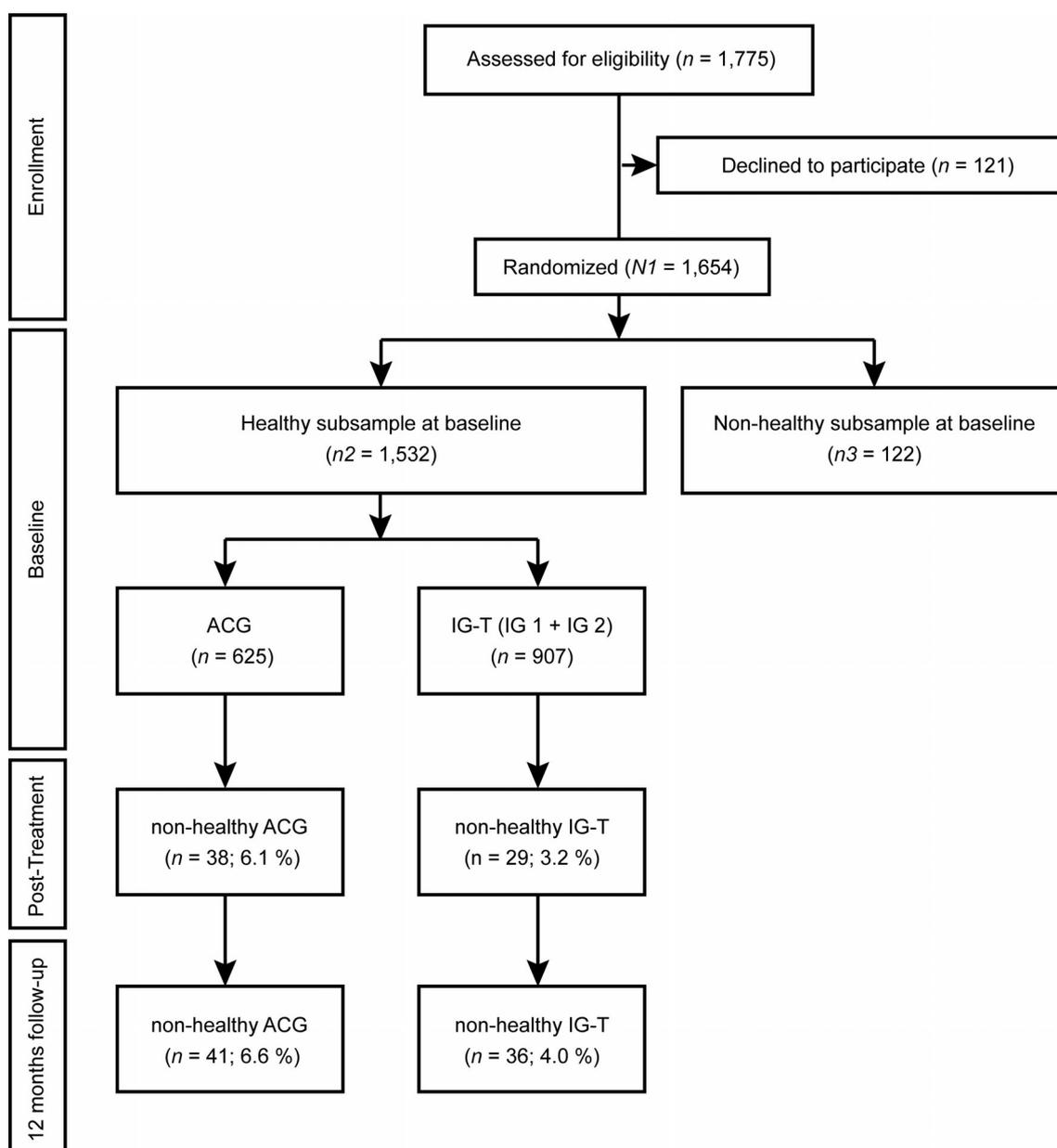


FIGURE 1 Study flow diagram. ACG, active control group; IG 1, intervention group one; IG 2, intervention group 2; IG-T, intervention group total

students, 625 students were randomized to the ACG and 907 students to the MaiStep group (IG-T), which was further divided into students for whom MaiStep was delivered by psychologists (IG 1 = 460) and by teachers (IG 2 = 447). Further information is provided in Figure 1.

3.2 | Efficacy analysis (H1)

For post-treatment and the 12-month follow-up, the students were categorized into healthy and nonhealthy according to the SIAB-S. Thirty-eight (6.1%) out of 625 students in the ACG (95%-CI = [27, 52; Newcombe, 1998; Wilson, 1927) fulfilled criteria for any eating disorder at posttreatment, versus 29 (3.2%) out of 907 students in the IG-T (95%-CI = [20, 42]; Newcombe, 1998; Wilson, 1927). At the 12-month follow-up, 41 (6.6%) out of 625 students in the ACG (95%-CI = [30, 55]; Newcombe, 1998; Wilson, 1927) fulfilled the criteria for any eating disorder, versus 36 (4.0%) students out of 907 students in the IG-T (95%-CI = [26, 50]; Newcombe, 1998; Wilson, 1927). The majority of new cases were diagnosed with atypical AN or purging disorder in both the ACG and IG-T.

Regarding hypotheses 1a and 1b, McNemar's χ^2 tests revealed significant differences between the ACG and IG-T at posttreatment ($\chi^2(1) = 7.352, p = .007$) and at 12-month follow-up ($\chi^2(1) = 5.203, p = .023$), indicating significantly fewer eating disorder cases in the MaiStep group (IG-T) compared to the ACG. Relative risk and ORs were calculated for posttreatment and 12-month follow-up, resulting in a $RR = .61$ and an $OR = .59$ (12-month follow-up), thus revealing a reduced risk of developing an eating disorder in the IG-T compared to the ACG at 12-month follow-up ($RR = .53$; $OR = .51$ for post-treatment, Table 2).

3.3 | Cost-benefit analysis (H2)

The absolute risk in the ACG at 12-month follow-up was projected to the group size of the IG-T, revealing that 60 students in the IG-T would have been expected to fulfill the criteria for any eating disorder at follow-up. In contrast, only 36 (95%-CI = [26, 50]) students in the IG-T actually fulfilled the criteria for any eating disorder at follow-up. As such, it can be concluded that MaiStep protected 24 (95%-CI = [10; 34]) students from developing an eating disorder (Figure 2, Table 2).

In terms of the overall cost-benefit analysis, we accordingly compared costs for 907 students (97,230.40 €) taking part in MaiStep to the health care costs of 24 (95%-CI = [10; 34]) eating disorder cases (656,386.08 €; 95%-CI = [273,494.20 €; 929,880.28 €]), resulting in savings of 559,155.68 € (95%-CI = [176,263.80 €; 832,649.88 €]) for the health care system. The average program cost per averted eating disorder case lies at 4,051.27 € (95%-CI = [9,723.04 €; 2,859.72 €]), and the benefit-cost ratio is $t_{cbr} = 6.75$ (95%-CI = [2.81; 9.56]).

For every 1,000 students receiving MaiStep rather than a universal prevention program for stress prevention, 26 (95%-CI = [11; 37]) eating disorders would be prevented, amounting to cost savings of

TABLE 2 Overview of protective effects of MaiStep

Item	Value
Expected number of students fulfilling criteria for any ED in ACG at follow-up ($n = 625$)	30
Students fulfilling criteria for any ED in ACG at follow-up ($n = 625$)	41
Expected number of students fulfilling criteria for any ED in IG-T at follow-up based on illness rate of ACG at follow-up ($n = 907$)	60
Actual number of students fulfilling criteria for any ED in IG-T at follow-up ($n = 907$)	36 (95%-CI = [26;50])
Protected students	24 (95%-CI = [10; 34])
OR(IG-T:ACG) post-treatment	0.51
OR(IG-T:ACG) follow-up	0.59
RR posttreatment	0.53
RR follow-up	0.61

Abbreviations: ACG, active control group; ED, eating disorder; IG-T, intervention group total, OR, odds ratio; RR, relative risk.

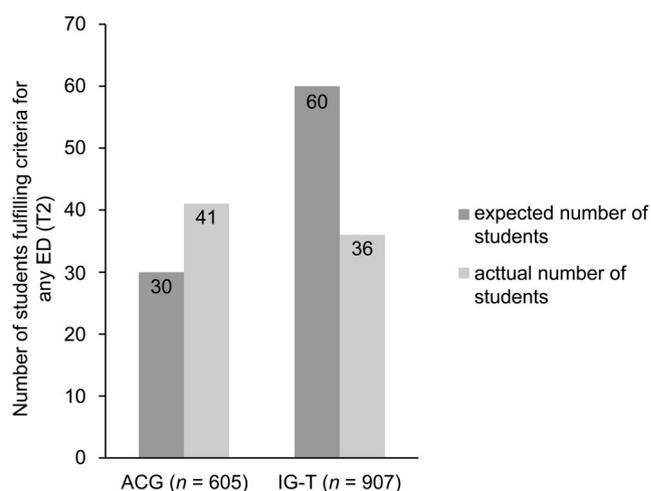


FIGURE 2 Comparison of preventive effects in ACG and IG-T at 12-month follow-up (T2). ACG, active control group; IG-T, intervention group total

601,388.19 € (95% CI = [179,236.17 €; 902,925.35 €]) Euros. From 2012 until the end of 2019, almost 22,000 students participated in MaiStep, resulting in savings of approximately 13.2 (95%-CI = [3.9; 19.8]) million € for the German health care system.

4 | DISCUSSION

To the best of our knowledge, this is the first study to analyze the efficacy of universal prevention for eating disorders in regard to direct diagnostic entities and in relation to cost-benefit. On the basis of DSM-5 diagnostic criteria, the results confirmed the preventive effects of MaiStep according to questionnaire measures (Buerger

et al., 2019). Significantly fewer adolescents in the IG-T fulfilled the criteria for a DSM-5 eating disorder at posttreatment and at 12-month follow-up as compared to those in the ACG. As an universal prevention program addressing specific eating disorder risk factors, MaiStep significantly reduced incidence rates for eating disorders. These findings are in line with other research (Sanchez-Carracedo et al., 2016; Wilksch, 2017), but extend previous findings on direct diagnostic criteria via self-report. Moreover, the present findings complement the existing research with a categorical approach based on DSM-5 diagnostic criteria. Analogous to secondary prevention programs such as that developed by Akers et al. (2017), this approach might underscore the efficacy of universal prevention with measures of high criterion validity.

Although MaiStep did not prevent all cases of eating disorders, the incidence rates in the IG-T were significantly reduced compared to the ACG. The taught skills focusing on risk factors such as internalization of the beauty ideal, on reducing body image avoidance and negative affect, or on improving self-efficacy may have been sufficient for some participants at risk, but others may have needed more frequent or more intense prevention or intervention units. Although significant at both assessments after the training, the preventive effects decreased from post-treatment to 12-month follow-up. To preserve the universal preventive effect, long-term results could be improved by implementing booster sessions (Stice, South, & Shaw, 2012). Moreover, a stepped approach including universal prevention training as a first-line program, in conjunction with screening measures to establish links to secondary prevention with interventional content, might be promising.

Besides the evaluation of efficacy using a controlled design, we also included a cost-benefit evaluation. In particular for political decision-makers, the cost-benefit ratio is highly relevant for the decision whether or not to implement a prevention program. In this sample, MaiStep proved to be cost-effective and to reduce expenses for the German health care system, as it saved 601,388.19 € per 1,000 students participating in MaiStep. Even when considering the lower boundary of the CI, MaiStep proved to be cost-beneficial.

Following a conservative approach in this analysis, the proportions of different eating disorders were derived by integrating the prevalence rates reported in three studies in adolescents (Allen et al., 2013; Flament et al., 2015; Mitchison et al., 2020). AN is associated with the highest cost for the health care system, and the calculated savings therefore might represent a conservative estimate. Additionally, despite preventive efforts being regularly scheduled in school curricula in Germany, we included indirect program costs for implementation by teachers. Taken together, from a monetary perspective, the savings in terms of universal prevention of eating disorders brought about by conducting MaiStep outweighed the costs of program delivery.

4.1 | Limitations and strengths

Some limitations of the present study should be mentioned. The sample of this study is based on a population of adolescents at middle-school age from only one Federal state in Germany. As such, this selectivity

may have influenced our results. With the SIAB-S, we used a reliable and valid diagnostic measure, but we must nevertheless acknowledge the limitations of self-report assessments per se. Moreover, the validation of the SIAB-S was conducted with adult participants (Fichter & Quadflieg, 1999), which may have led to distortions in ED diagnosis. Data from Krauth et al. (2002) were used as the basis to calculate expenses of eating disorders. To counteract the impact of inflation, we used yearly inflation rates in Germany as presented by the German Federal Statistical Office and projected these to € 2019. A further aspect is the lack of reliable medical expenses for BED and OSFED, which is why we had to replace them with the BN values. According to Ágh et al. (2016), it is necessary to conduct a differentiated analysis of costs for each eating disorder diagnosis. Additionally, some students classified with an ED diagnosis may not have received treatment or may have remitted spontaneously, which would lower the calculated health care costs (Vandereycken, 2012). Due to the statutory health insurance system in Germany, most adolescents seeking treatment will receive it, but comparability to other countries with different insurance systems may be reduced. The present cost-benefit analysis was based on a comparison to an ACG (the standard school-based prevention in Rhineland-Palatine, Germany). This approach may reduce the generalizability to other countries. It should be further noted that the sole consideration of monetary benefits does not reflect the benefits of prevention programs in their entirety. Therefore, future studies, especially on eating disorders, should consider aspects pertaining to quality of life (Ágh et al., 2016; Bode et al., 2017). Finally, the comparability of the findings is limited due to a lack of studies analyzing the cost-benefit of eating-disorder prevention programs.

Nevertheless, several strengths of our study can be noted. To the best of our knowledge, only a small number of studies have measured efficacy using direct diagnostic criteria via self-report according to the DSM-5. A further strength lies in the large sample of both adolescent girls and boys under the age of 15, with very low drop-out rates. Considering the increasing risk of eating disorders in boys (Mitchison & Mond, 2015), universal prevention should target both girls and boys. The majority of preventive programs examine efficacy under standardized conditions with female participants only (Le, Hay, & Mihalopoulos, 2017). In contrast, MaiStep addresses all genders with gender-specific material for example, pictures, video clips.

In contrast to other universal prevention programs focusing mainly on efficacy, this evaluation of MaiStep also included the assessment of cost-benefit ratios. Economic aspects are highly relevant for political decision-makers, health insurance companies or school administrators in deciding whether or not to implement a prevention program. Besides the efficacy in terms of universal prevention, MaiStep also seems to be cost-effective, based on the presented data. While recent literature (Le, Hay, & Mihalopoulos, 2017) merely examined direct health care costs, we based our analysis on data from Krauth et al. (2002) and also included indirect health care costs (comorbidity, deficit in work force). Indirect costs caused, for example, by concomitant and secondary disease as well as high morbidity rates, play a particularly significant role among eating disorders. Therefore, it seems necessary to analyze programs in regard to both efficacy and cost-benefit ratios.

4.2 | Conclusion

Overall, school-based prevention can have a beneficial effect in terms of reducing eating disorder incidence rates according to the DSM-5. Furthermore, MaiStep may be cost-effective and its implementation could lead to savings for the health care system. Future studies should also analyze quality of life alongside cost-benefit calculations.

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CONFLICT OF INTEREST

The authors declare no conflict of interest.

DATA AVAILABILITY STATEMENT

No data sharing provided.

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