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RE-AIM evaluation of a one-year trial of a combined educational and environmental workplace intervention to lower salt intake in Switzerland

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ABSTRACT

Reducing excessive dietary sodium may reduce cardiovascular disease risk. Environmental and behavioral interventions in workplaces may reduce salt consumption, but information on the effectiveness of workplace nutrition interventions is sparse. We used the RE-AIM framework to evaluate a one-year trial in 2015–2016 of an educational and environmental intervention to lower salt intake of employees in organizations with catering facilities in Switzerland. Five educational workshops for employees and assessments that included 24-hour urine collection were combined with five coaching sessions and food analyses in catering operations. We studied the adoption, reach, implementation, effectiveness, and maintenance of the intervention.

Eight of 389 candidate organizations participated in the trial in which 145 (50% men) out of 5794 potentially eligible employees consented to participate, and 138 completed the trial with 13 in the control group.

The overall mean change of daily salt intake was −0.6 g from 8.7 g to 8.1 g (6.9%). Though the mean daily salt intake of women was unaltered from 7 g, the mean intake of men declined by −1.2 g from 10.4 g to 9.2 g. Baseline salt intake, sex, and waist-to-height ratio were significant predictors of salt reduction. The analysis also highlighted pivotal determinants of low adoption and reach, and program implementation in catering operations. We conclude that a workplace program of nutrition intervention for employees and catering staff is feasible. The acceptance, effectiveness, and maintenance of nutrition interventions in the workplace require strong employer support. In a supportive food environment, interventions tailored to sex, age, and CVD risk inter alia could be successful.

1. Background

Around 27% of adults have been diagnosed with hypertension at least once during their life in Switzerland (Federal Statistical Office (FSO), 2013; Glatz et al., 2017), where 32% of deaths are attributed to cardiovascular disease (CVD) (Federal Statistical Office (FSO), 2017). Because excessive dietary sodium (Na) intake is associated with the CVD risk factor high blood pressure (Cook et al., 2016; Glatz et al., 2017; Mozaffarian et al., 2014), lowering Na or salt intake may be a cost-effective way to reduce death from CVD (Beaglehole et al., 2011). The Swiss government therefore intends to reduce mean population salt intake (Bundesamt für Gesundheit (BAG) und Schweizerische Konferenz der kantonalen Gesundheitsdirektorinnen und -direktoren (GDK), 2016; Federal Food Safety and Veterinary Office (FSVO), 2017; Federal Office of Public Health, 2013), currently 9.5 g/day (women 8 g/day, men 11 g/day) (Beer-Borst et al., 2009; Chappuis et al., 2011), through environmental and behavioral interventions to below 8 g/day in the intermediate term and 5 g/day long term as recommended by the World Health Organization (World Health Organization (WHO), 2012).

The variety of factors that influence eating compel similarly varied interventions to alter nutritional intake (Geaney et al., 2016; Geaney et al., 2013; Shain and Kramer, 2004; World Health Organization (WHO), 2013). The workplace is one setting in which educational and environmental interventions can be combined (Mozaffarian et al.,

Abbreviations: BMI, body mass index; CVD, cardiovascular diseases; CI, confidence interval; FL, food literacy; FSVO, Food Safety and Veterinary Office; HL, health literacy; HP, health promotion; K, potassium; Na, sodium; t0, baseline; t3/t6/t9, follow-up at 3, 6, 9 months; t12, study end; WHtR, waist-to-height ratio

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2012) to engage a large number of people of varying ages and socioeconomic status who otherwise would be difficult to reach. Employees spend 50–70% of daily waking hours at work where often they are provided food in staff canteens. However, systematic reports on the effectiveness of combined interventions in such settings are scarce (Geaney et al., 2013; Hawkes, 2013; World Health Organization and World Economic Forum, 2008).

We adopted the RE-AIM framework (Glasgow et al., 1999) to guide assessment of the impact of a one-year combined educational and environmental workplace intervention trial to lower salt intake in Swiss employees. The study collected data informing five dimensions of the intervention: adoption, reach, implementation, effectiveness, and maintenance.

2. Methods

A detailed description of the study protocol along CONSORT guidelines is available elsewhere (Beer-Borst et al., 2018). Swissethics approved the trial that was registered in the German Clinical Trials Register (DRKS00006790, 23.09.2014).

2.1. Study objective, design, and participants

The nonrandomized health promotion (HP) trial “Healthful & Tasty: Sure!” was carried out in workplaces in eight German-speaking cantons of Switzerland between May 2015 and November 2016. The trial assessed the effectiveness of a 12-month educational and environmental intervention in reducing average 24-hour urinary Na excretion (salt intake) by 15% with alpha 0.05 and 80% power.

The initial design was a cluster randomized controlled trial. The calculated necessary sample size was eight intervention and eight control clusters, with 50 participants per cluster allowing for 25% dropout. Due to recruitment problems (see Section 3.1 Adoption, below), the design was changed to a cluster nonrandomized single-arm trial with calibration arm. This alteration required participation of seven intervention clusters with a threshold of 112 participants before 10% dropout (Beer-Borst et al., 2018).

The workplace settings consisted of public and private organizations with catering facilities. Organizations and their catering companies signed gatekeeper contracts covering their participation in either the intervention or control group. Management at the study organizations solicited employee participation according to their own communication and privacy policies. Employees aged 15 to 65 years received invitations to an on-site information session that included a written study outline and inclusion and exclusion criteria. All study participants provided written informed consent.

2.2. Educational intervention

Intervention group participants were offered a food literacy (FL)-based education program for improvement of their nutrition knowledge and their abilities and skills to choose food both at home and away from home (Jent and Eisenblätter, 2017). The program promoted a balanced diet with adequate salt content and addressed consumption of potassium (K)-rich foods apart from measures to lower salt intake. The program had four three-month cycles and it was comprised of five interactive, practice-oriented workshops; additional information and practical assignments were provided via e-mail between workshops. The third workshop offered an exchange platform for participants and the catering team. In the final workshop, participants addressed issues raised in the completed evaluation questionnaire and reflected on dietary changes and their maintenance.

2.3. Environmental intervention

Following initial meetings with the catering operation management and staff, catering teams in the intervention group were coached over the course of four three-month cycles (Siegenthaler and Beer-Borst, 2017) to help them apply recognized national guidelines for communal catering (Forschungsgruppe Good Practice-Gemeinschaftsgastronomie, 2015) in implementing salt reduction measures. A coach first offered background information to strengthen nutritional knowledge and acceptance of salt reduction measures that had been established with a project group including chef and staff members. The measures were tested in the kitchen and reviewed at regular intervals. The overall evaluation of the coaching program relied upon a questionnaire completed by catering managers and staff, and a discussion with them and an organization representative about achievements in salt reduction and potential for continuing activities.

2.4. Outcome measures

Primary outcome was the change of average Na/salt intake at group level between baseline (t0) and study end (t12). Secondary outcomes were individual participant dietary changes using the Na/K ratio as a quality indicator, health literacy (HL) and FL, and blood pressure and anthropometric measures. For catering operations, outcome measures were change in Na/salt and K content of luncheons with particular focus on the most commonly consumed, standard plated menu with meat or fish.

2.5. Data collection

At t0 and t12, all participants completed a 68-item health questionnaire assessing demographic and socioeconomic, health status, and health-behavior characteristics. It integrated specific tools and questions to measure HL and FL, nutrition self-efficacy, and salt awareness (Beer-Borst, 2017).

Participating organizations also were asked for permission to invite nonparticipating employees to complete an anonymous online survey. The survey combined the health questionnaire with a set of 19 items inquiring about reasons for nonparticipation (Beer-Borst, 2017; Nöhammer et al., 2014).

In the intervention group, participants attended the education program and had five individual follow-up health assessments. Measurements included blood pressure, heart rate, body weight, height (only t0), and waist and hip circumference from which body mass index (BMI) and waist-to-height ratio (WHtR) were calculated (Beer-Borst et al., 2018). Na/salt and K intakes were estimated using three methods during three-day periods at t0 and t12. A food record checklist, which provided semiquantitative information on food sources of Na and K intake (day 1–3) (Beer-Borst et al., 2017), a late afternoon spot urine (day 2) and a 24-hour urine (day 3) collection according to standard procedures (Beer-Borst et al., 2018). Urine specimens were analyzed in a private accredited medical laboratory. Participants received personalized summaries of urinary measurement results twice, during and at the intervention's end.

Before the start of the intervention and during follow-up, we used questionnaires to gather information characterizing the catering facilities, and assess the staffs' guideline awareness, attitudes, and self-efficacy; and evaluate coaching (Azanza and Zamora-Luna, 2005; Beer-Borst, 2017). At the start and end of each cycle, the production processes of the different menu components were documented, and we took samples of foods products at point of service for analysis of Na and K content in the Federal Food Safety and Veterinary Office (FSVO) laboratories.

In the control group, data were collected three times (t0, t6, t12). Participants and catering management received personalized summaries of results at a nutrition education event organized after the last follow-up.

Study staff checked all returned documents for completeness and inconsistencies prior to data entry. We collaborated with the Clinical

Table 1
Overview of indicators as per RE-AIM dimensions.

Dimensions	Indicators
Reach	Individual level
	Number of eligible participants in the target population
	Number and reasons of exclusions
	Number of eligible participants who were offered participation
	Percent participation and percent drop-out
	Characteristics of participants and nonparticipants (representativeness of participants)
	Most common reasons for accepting and for declining participation
Effectiveness	Individual level
	Impact of the intervention on primary outcome
	Impact of the intervention on secondary outcomes
	Cluster/catering level
	Change in salt content of the catering offerings (standard plated menu)
Adoption	Cluster/organizational level
	Number of eligible organizations with catering facility
	Number of organizations invited to participate in the trial
	Number of organizations that agreed to participate in the trial
	Proportion of eligible organizations contacted to participate
	Proportion of eligible organizations excluded from the study, also refusals
	Proportion of participation among contacted organizations
	Characteristics of participating and nonparticipating organizations (representativeness of organizations)
	Most common reasons for nonparticipation
	Contact person at each organization
Implementation	Individual and cluster level
	Intervention agents
	Extent to which the interventions were delivered as intended
	Intervention intensity (e.g. timing, duration, frequency)
	Consistency across settings for interventions and follow-up assessments
Maintenance	Cluster and individual level
	Institutionalization of the programs at stakeholder and policy level
	Long-term effects of the program (sustainability rating)

Trials Unit, University of Bern for central data collection and management using REDCap (Research Electronic Data Capture) (Harris et al., 2009).

2.6. RE-AIM evaluation

The RE-AIM framework (Glasgow et al., 1999) supports impact evaluation of interventions in real world settings. Table 1 summarizes the indicators that refer to data collected from the participants and organization and catering facility staff.

2.7. Statistical analysis

We summarized baseline variables for the intervention and control groups separately, and for nonresponders. The pre-post data analyses were restricted to the intervention group. The control group differed noticeably from the intervention group in size and in baseline Na/salt intake and was therefore not included in inferential analysis.

According to study protocol (Beer-Borst et al., 2018), a linear mixed model with organization as random effect was applied to assess the change in Na/salt intake from t0 to t12. Since the effect of organization was negligible, we used a *t*-test, and due to distinct differences in intake of women and men at t0, the *t*-test was also applied separately by sex. The effect of predefined explanatory variables on change in salt intake was assessed using linear regression models with backward selection overall and separately by sex.

We summarized continuous variables descriptively using mean and 95% confidence interval (CI) or median and range depending on sample size and type of variable. Frequency and percentage were calculated for categorical variables.

Changes from t0 to t12 were summarized for the whole intervention group and by sex. For continuous variables, comparisons between t0 and t12 were performed with *t*-tests. We compared categorical variables at t0 and t12 with Fisher's exact tests. Two-tailed tests with significance level 0.05 were applied for all analyses.

Because all analyses except the primary endpoint analysis were exploratory and hypothesis generating we did not adjust for multiple testing. All analyses were performed using R 3.3.2 (The R Foundation, 2017).

3. Evaluation results and discussion

3.1. Adoption

We identified and contacted 389 organizations with catering facilities that were potentially eligible to participate in the HP trial, 146 of which (37.5%) never responded (Fig. 1). Among the 243 responding organizations, 49 failed to meet the inclusion criteria, and 186 declined to participate primarily due to lack of resources (Tables 2 and A.1). This was a complex intervention related to research, initiated externally (Rojatz et al., 2017), and it required a long-term commitment (Steenhuis et al., 2001); half of the organizations that declined nevertheless indicated support for HP measures (Fig. 1).

Management in eight organizations (2.1%) accepted participation, which represented the same fields of activity as the nonparticipating organizations (Table 2). Seven organizations requested participation in the intervention group, and one organization participated as a control due to the preference of its catering firm. Randomization contradicted economic commitment to best return on investment, and in some settings nutritional health also was perceived as an issue of individual responsibility sans specific, personal interest in the subject on the part of top management (Pescud et al., 2015; Shain and Kramer, 2004). Leadership support is key for adoption and reach of HP programs (Crump et al., 1996; Hopkins et al., 2012; Milner et al., 2015), and for overall trial success. We thus did not achieve the intended cluster randomized controlled design (Beer-Borst et al., 2018), which reduces the quality of the trial's findings (Maes et al., 2012). At the same time, this seeming failure to achieve our methodological ideal greatly informs future implementation of workplace salt reduction strategies.

3.2. Reach

Across the eight organizations in both study arms, 5794 employees were invited to participate in the trial (Fig. 1; Table A.2). Among these employees (Table 2), 156 (2.7%) registered for participation. Two failed to meet inclusion criteria, eight provided no written consent, and one registered after intervention start. Seven of the 145 participants (4.8% or 0.1% of all eligible employees) dropped out. The remaining 138 employees who completed the trial, 125 in the intervention and 13 in the control group, showed high commitment.

As in other HP programs, organizational, personal, and interpersonal factors influenced participation in the trial (Linnan et al., 2001). The research group relied on organizations' communication strategies for reaching employees, which may partly explain why almost half of nonresponders reported having received no invitation to participate. Many nonparticipants who had seen the invitation felt the required commitment was too large (Table A.3). The health assessments, in particular the recurring urine collections were a major strength of the trial, but such procedures are time-consuming, complex, and burdensome (Nöhammer et al., 2014; Techau et al., 2014). Other interventions to reduce salt intake and which applied 24-hour urine collections typically have been of shorter duration or targeted risk

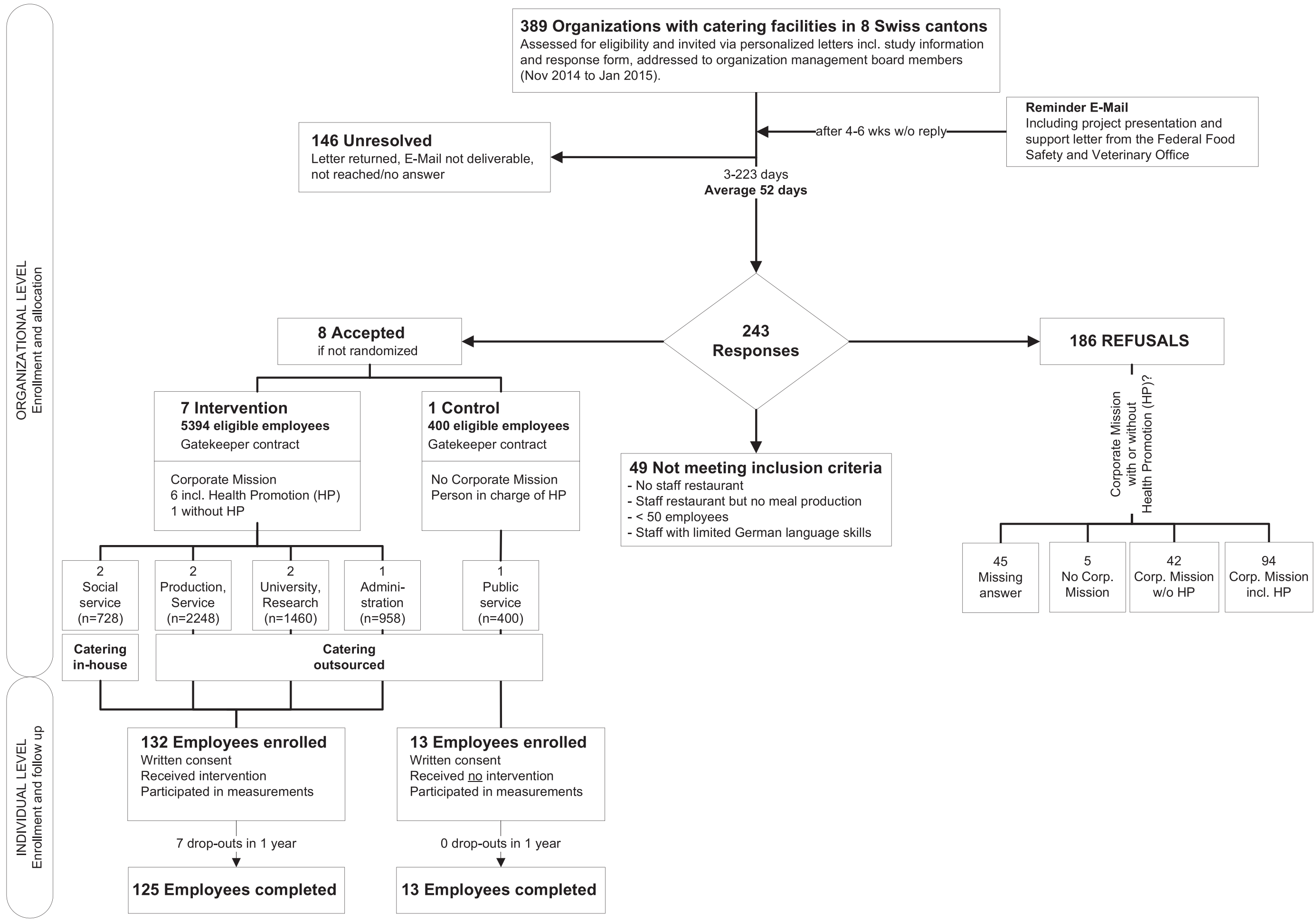

Fig. 1. Flow diagram from enrollment to study end at organizational and individual participant level.

groups (Trieu et al., 2017). Appendix table A.4 list motives for participation in the intervention group; reported motives are similar to those in other trials (Arcand et al., 2013; Lakerveld et al., 2008; McCann et al., 2010).

Table 3 presents an overview of baseline characteristics of the intervention and control group participants, and 230 nonparticipants who completed a non-responder survey. Several factors limit generalization of the findings to other working populations. Management of only three organizations in the intervention arm along with the one control organization granted permission for the survey of nonresponders (Tables 3 and A.2). Respective participation of women and men in the study was nearly equal, though this has not been the case in the

Table 2
Evaluation results as per dimensions of adoption and reach.

Dimension	Indicators		
	Cluster/organizational level	N	%
Adoption	Eligible organizations with catering facility,	389	100
	of which	n	%
	Reached to participate in the trial	243	62.5
	Excluded from the study, also refusals	235	60.4
	Agreed to participate in the trial	8	2.1

Dimension	Indicators	All		Intervention group		Control group	
	Individual level	N	%	N	%	N	%
Reach	Eligible participants in the target population,	5794	100	5394	100	400	100
	of which	n	%	n	%	n	%
	Registered for participation	156	2.7	143	2.7	13	3.3
	Excluded	11	0.2	11	0.2	0	0
	Enrolled	145	2.5	132	2.4	13	3.3
	Dropped-out	7	0.1	7	0.1	0	0
	Completed the trial	138	2.4	125	2.3	13	3.3

Table 3
Baseline characteristics of participants by study arm, and of nonparticipants[a].

Characteristics		Intervention group	Control group	Nonparticipants
Number organizations	N	7	1	4
Demographic and socioeconomic				
Number participants	N	128[b]	13	230
Women	n (%)	65 (50.8%)	5 (38.5%)	155 (67.4%)
Men	n (%)	63 (49.2%)	8 (61.5%)	75 (32.6%)
Age (years)	Median (range)	46 (21, 61)	48 (30, 59)	39 (16, 65)
	Mean (95% CI)	44.1 (42.2, 46)	49.3 (44.6, 54)	40.4 (38.9, 41.8)
15–34	n (%)	31 (24.2%)	1 (7.7%)	78 (33.9%)
35–44	n (%)	23 (18.0%)	1 (7.7%)	70 (30.4%)
45–54	n (%)	45 (35.2%)	8 (61.5%)	52 (22.6%)
55–65	n (%)	29 (22.7%)	3 (23.1%)	30 (13.0%)
Nationality				
Swiss	n (%)	107 (83.6%)	12 (92.3%)	138 (60.0%)
Non-Swiss	n (%)	21 (16.4%)	1 (7.7%)	92 (40.0%)
Education				
Primary/obligatory	n (%)	2 (1.6%)	0 (0.0%)	4 (1.7%)
Secondary	n (%)	34 (26.6%)	1 (7.7%)	39 (17.0%)
Tertiary	n (%)	92 (71.9%)	12 (92.3%)	187 (81.3%)
Worktime equivalent (% full time equivalent)	Median (range)	100 (40, 100)	90 (60, 100)	90 (0, 100)
	Mean (95% CI)	90.8 (88.4, 93.3)	86.5 (78.8, 94.3)	84.2 (81.8, 86.5)
Proportion full time	n (%)	50 (39.1%)	9 (69.2%)	99 (43.0%)
Proportion part time	n (%)	78 (60.9%)	4 (30.8%)	131 (57.0%)
Employment type				
Mostly manual work	n (%)	14 (10.9%)	0 (0.0%)	8 (3.5%)
Mostly sedentary work	n (%)	113 (88.3%)	13 (100.0%)	222 (96.5%)
N/A	n (%)	1 (0.8%)	0 (0.0%)	0 (0.0%)
Health status				
Self-rated health				
Bad and very bad	n (%)	0 (0.0%)	0 (0.0%)	0 (0.0%)
Moderate	n (%)	8 (6.2%)	1 (7.7%)	15 (6.5%)
Good and very good	n (%)	120 (93.8%)	12 (92.3%)	215 (93.5%)
Chronic conditions (last 6 months, ongoing)				
Yes	n (%)	38 (29.7%)	5 (38.5%)	72 (31.3%)
No	n (%)	90 (70.3%)	8 (61.5%)	158 (68.7%)
Hypertension awareness[c]				
Yes	n (%)	22 (17.2%)	3 (23.1%)	24 (10.4%)
No	n (%)	104 (81.2%)	10 (76.9%)	202 (87.8%)
Don't know and N/A	n (%)	2 (1.6%)	0 (0.0%)	4 (1.7%)
Health behavior				
Physical activity[d]				
Meeting WHO recommendations for health	n (%)	121 (94.5%)	13 (100.0%)	166 (72.2%)
Daily time spent sitting (min/day)	Mean (95% CI)	451.4 (417.5, 485.3)	445.4 (327, 563.8)	542.2 (517.5, 567)
Smoking				
Never	n (%)	73 (57.0%)	8 (61.5%)	124 (53.9%)
Former	n (%)	33 (25.8%)	5 (38.5%)	72 (31.3%)
Current	n (%)	21 (16.4%)	0 (0.0%)	34 (14.8%)
N/A	n (%)	1 (0.8%)		
Literacy				
Health literacy (HL), health promotion HL index[e]	Mean (95% CI)	32.3 (31.2, 33.3)	34.2 (30.6, 37.8)	34.4 (33.4, 35.3)
Inadequate (25 or less)	n (%)	18 (14.1%)	0 (0.0%)	24 (10.4%)
Problematic (> 25–33)	n (%)	55 (43.0%)	6 (46.2%)	69 (30.0%)
Sufficient (> 33–42)	n (%)	47 (36.7%)	4 (30.8%)	99 (43.0%)
Excellent (> 42–50)	n (%)	8 (6.2%)	3 (23.1%)	34 (14.8%)
Food literacy (FL) score[e]	Mean (95% CI)	36.5 (35.4, 37.5)	36.3 (33.5, 39.1)	38.9 (38.1, 39.7)
Salt awareness				
No discretionary salt use	n (%)	62 (48.4%)	4 (30.8%)	69 (30.0%)
Know recommended salt intake	n (%)	67 (52.3%)	6 (46.2%)	121 (52.6%)
Salt content impacts food/menu choice	n (%)	58 (45.3%)	3 (23.1%)	86 (37.4%)

[a] Permission to conduct the anonymous online nonresponder survey was required. Three organizations in the intervention group and the control group organization assented to the survey.
[b] Allocated to receive intervention and to baseline analysis n = 132; allocated to primary analysis n = 128 due to exclusion of four missing or inadequate 24-hour urine samples.
[c] Awareness was assessed using the question, "Has a health professional told you at least once that you are hypertensive?"
[d] According to Global Physical Activity Questionnaire (WHO), 150 min moderate intensity PA or 75 min vigorous intensity PA, or equivalent combination achieving 600 + MET per week (Beer-Borst, 2017).
[e] Health promotion HL index 0–50, FL score 7–52, more points = more literate (Beer-Borst, 2017).

nonresponders survey and other studies (Glasgow et al., 1993; Robroek et al., 2009).

Concerning representativeness, both, participants and nonparticipants were mainly persons with higher education who had, on average, fair HL and FL, and rated their health as good or very good; but more participants than nonparticipants rated themselves as salt-aware. Those who were aware of being hypertensive, along with those who were salt-aware, may have been more motivated to enroll, which would suggest selection bias. However, the evidence for health-related factors as a determinant of participation (Linnan et al., 2001) is inconsistent across HP programs (Robroek et al., 2009).

3.3. Implementation

This multicenter trial with a centrally located team of five intervention agents proved feasible, and was implemented as planned. Neither major problems nor adverse incidents occurred. Sophisticated logistics, with a few adjustments to coordinate the schedules of the interventions, assessments, and laboratory analysis, were necessary to avoid missing data (Table A.5). The education program was adjusted slightly for each organization, and the workshop discussions varied across organizations, given differing questions and interests of participants and the group dynamics in the different settings. The number of health assessments was reduced to remain in sync with the educational intervention and clearly separate follow-up health assessments within an organization; this lowered the burden on participants. Participants attended baseline and study-end assessments as planned, and most followed the three-day urine collection protocol as arranged and complied with instructions. The catering intervention provided proof of concept (Beer-Borst and Sadeghi, 2011; Sadeghi et al., 2013). The intervention program required flexibility because lack of time and personnel, and economic fears rendered implementation of a continuous improvement process difficult. Although well known, these barriers (Park and Lee, 2015; Steenhuis et al., 2001) were unpredictable in a real-world intervention with randomly recruited workplaces.

3.4. Effectiveness

3.4.1. Primary outcome

The overall mean (95% CI) change of daily salt intake was −0.6 g from 8.7 g to 8.1 g (−1.5, 0.3) or 6.9% over 12 months (Table 4). The mean daily salt intake of women of 7 g did not change (0 g (−1.2, 1.1)), that of men declined by −1.2 g from 10.4 g to 9.2 g (−2.6, 0.2) or 11.5% (Table A.6). This reduction, although not statistically significant, is promising when seen in the context of the intermediate goal of the Swiss strategy to reduce mean population salt intake by 16% in four years (4% per year) to an overall level of no more than 8 g/day (Federal Office of Public Health, 2013).

A linear regression model showed overall that baseline salt intake, sex, and WHtR were significant predictors of salt reduction over time (Table 5; full model Table A.7). For each gram of additional salt intake at t0, the salt reduction was 1 g; accounting for baseline salt intake, women would have achieved a 1.8 g higher mean salt reduction than their male counterparts. Additional sex-specific modeling revealed that baseline salt intake was solely explanatory of salt intake reduction for men, whereas for women age and WHtR also explained change in salt intake (Table 5).

The overall impact of our environmental intervention on participants' salt intake would appear to be negligible. Scrutinized more closely, the results suggest that it will be harder to see the effects of interventions at lower mean salt intake levels. However, modular interventions tailored to sex, age, and CVD risk profile, along with a supportive food environment may overcome this dilemma. Other projects in different settings have reported salt reduction of similar magnitude (Geaney et al., 2016; He et al., 2015; Land et al., 2014; Land et al., 2016). In a cluster controlled trial based in selected Irish manufacturing workplaces (Geaney et al., 2016), a nutrition education intervention alone achieved the same mean salt intake reduction we observed (−0.6 g/day), but in combination with a comparable catering intervention salt intake of employees declined by −1.4 g/day. The study overcame adoption issues that we faced and thus could include a sufficiently large control group, though it relied upon 24-hour dietary recall to estimate sodium intake. We cannot draw any firm conclusion about causality lacking a strong calibration arm. In the sole control organization, salt intake decreased, but due to small group size and higher baseline salt intake than in the intervention group comparison was not considered appropriate (Fig. B.1).

3.4.2. Secondary outcomes

Most changes of secondary outcomes (Table 4) were statistically significant, but not necessarily clinically relevant.

The mean Na/K ratio—which is a proxy for diet composition—and mean K intake, as well as the consumption of fruits and vegetables, changed adversely (Tables 4 and A.6). In the final educational workshop, many participants said they were eating a more balanced and less salty diet, and those having planned concrete dietary changes rated their changes as successful. Still, participants reported everyday habits and constraints, their liking of abundant meals and a high-salt food environment as the most important barriers to dietary change and salt reduction (Table A.8). Changing dietary habits also takes time, and single assessments of Na and K intake at t0 and t12 may not reflect habitual diet given day-to-day and seasonal variability of food consumption. Food intake assessment using the food record checklist could have been subject to social desirability and potential recall bias. However, Na and K intake estimates from 24-hour urine excretions do not support that likelihood. Furthermore, questionnaires and assays indicated that changes in salt intake accompany slight improvements of HL index and FL score, and an increase in the proportion of salt aware persons (Tables 4 and A.6). The awareness variable "salt impacts food/menu choice" has been shown to be associated with salt intake (Luta et al., 2018), and other educational interventions have observed similar improvements (Geaney et al., 2016; Jackson et al., 2016; Land et al., 2016; Mendoza et al., 2014). It is possible, though, that participants' self-reported assessment of program effect was influenced by response-shift bias (Howard and Dailey, 1979; Rohs et al., 2001).

Weight did not change markedly. Blood pressure change was more often in a favorable direction (Tables 4 and A.6).

The coaching of the seven catering teams produced inconsistent overall changes in salt content of the most frequently consumed standard plated menu with meat or fish ranging from −2.4 to +3.2 g/serving (median 0.3) (Table 4; Fig. B.2). Change in K content was negligible. Nevertheless, the trial showed that the recommended upper level of 2.5 g salt per plated menu (Forschungsgruppe Good Practice-Gemeinschaftsgastronomie, 2015) is technically achievable, though stabilization failed when catering did not follow a strict, gradual reduction approach (Fig. B.2). In organizations with internal management of catering, compliance with salt reduction guidelines appeared to be more sustainable (Table A.9). In the final workshop discussions, support by catering management was recognized as key for a team to strive for substantial and sustained salt reduction in menus. Perceived barriers to implementation of salt reduction measures were the lack of skilled personnel, a high level of convenience foods, the need to constrain discretionary salt use, individual cooking and taste preferences, and that taste-detectable reduction in salt content may reduce sales. The number of food samples had to be restricted for reasons of time and cost, and food sampling had to adhere to regular production schedules. Thus different menus were sampled at follow-up, but the program focused on applying salt reduction measure per menu component, including serving-size considerations (Berkowitz et al., 2016), for best impact across offerings.

3.5. Maintenance

Limited time and fixed research funding (Swiss National Science Foundation (SNSF), 2013) did not allow assessment of longer-term maintenance of primary and secondary outcomes after the intervention's end. However, sustainability was addressed in the evaluation workshops among employees and catering staff.

Table 4
Overall changes of primary and secondary outcomes and related health behavioral variables, intervention group.

Outcomes		N	Baseline	Study end	Δ Change	p-value[a]
Salt intake[b] (g/day)	Mean (95% CI)	119	8.7 (8, 9.3)	8.1 (7.4, 8.8)	−0.6 (−1.5, 0.3)	0.192
≤ 5	n (%)		12 (10.1%)	25 (21.0%)		
5–8	n (%)		51 (42.9%)	41 (34.5%)		
> 8	n (%)		56 (47.1%)	53 (44.5%)		
Potassium intake (g/day)	Mean (95% CI)	119	3.1 (2.9, 3.3)	2.6 (2.4, 2.8)	−0.5 (−0.7, −0.3)	< 0.001
Na/K-ratio	Mean (95% CI)	119	1.1 (1.1, 1.2)	1.3 (1.2, 1.4)	0.2 (0, 0.3)	0.007
Fruit and vegetable intake[c] (servings/day)	Mean (95% CI)	122	2.4 (2.2, 2.7)	2 (1.8, 2.2)	−0.4 (−0.6, −0.2)	< 0.001
Health literacy (HL) index[d]	Mean (95% CI)	121	28.7 (27.7, 29.8)	30.1 (29, 31.2)	1.4 (0.5, 2.3)	0.003
Food literacy (FL) score[d]	Mean (95% CI)	121	35.9 (34.8, 37)	39 (38, 39.9)	3 (2.2, 3.9)	< 0.001
Salt awareness		125				
No discretionary salt use	n (%)		59 (47.2%)	75 (60.0%)		< 0.001
Know recommended salt intake	n (%)		65 (52.0%)	92 (73.6%)		< 0.001
Salt content impacts food/menu choice	n (%)		55 (44.0%)	87 (69.6%)		< 0.001
Blood pressure, measured[e]		125				
Optimal	n (%)		65 (52.0%)	73 (58.4%)		
Normal	n (%)		25 (20.0%)	18 (14.4%)		
High normal	n (%)		17 (13.6%)	12 (9.6%)		
Hypertension	n (%)		18 (14.4%)	22 (17.6%)		< 0.001
Weight status						
Body mass index (BMI) (kg/m^2)	Mean (95% CI)	125	24.6 (23.9, 25.3)	24.7 (24, 25.4)	0.1 (−0.1, 0.3)	0.322
Waist-to-height ratio (WHtR)	Mean (95% CI)	124	0.5 (0.488, 0.511)	0.491 (0.48, 0.503)	−0.008 (−0.012, −0.005)	< 0.001
Standard plated menu with meat/fish[f]		7				
Sales numbers per day	Median (range)		123 (58, 242)	97 (60, 238)	−1 (−59, 39)	
Serving size (g/plate)	Median (range)		520 (362, 590)	454 (390, 654)	−66 (−142, 292)	
Sodium content						
Na g/100 g	Median (range)		0.3 (0.3, 0.4)	0.4 (0.2, 0.4)	0 (−0.1, 0.1)	
Na g/serving	Median (range)		1.8 (1.1, 2.2)	1.7 (0.9, 2.3)	0.1 (−0.9, 1.2)	
Salt content[g]						
NaCl g/100 g	Median (range)		0.8 (0.7, 1.1)	0.9 (0.6, 1.0)	0.1 (−0.3, 0.3)	
NaCl g/serving	Median (range)		4.5 (2.8, 5.5)	4.4 (2.4, 5.9)	0.3 (−2.4, 3.2)	
Potassium content						
K g/100 g	Median (range)		0.3 (0.2, 0.3)	0.3 (0.2, 0.5)	0 (−0.1, 0.2)	
K g/serving	Median (range)		1.5 (0.7, 1.6)	1.3 (0.8, 2.1)	−0.1 (−0.7, 0.6)	

[a] *t*-Test for continuous variables, Fisher's exact test for categorical variables.
[b] Salt equivalent (NaCl) intake, calculated from sodium (Na) excretion in 24-hour urine, provided individuals had adequate urine collections at t0 and t12 (N = 119).
[c] According to food record checklist (Beer-Borst et al., 2017); not included: fruit and vegetable juice, soup or fruits and vegetables in mixed recipes, 1 serving = 120 g.
[d] Health promotion HL index 0–50, FL score 7–52, more points = more literate (Beer-Borst, 2017).
[e] Optimal systolic blood pressure SBP < 120 and diastolic blood pressure DBP < 80 mmHG, normal SBP 120–129 and/or DBP 80–84 mmHG, high normal SBP 130–139 and/or DBP 85–89 mmHG, hypertension SBP ≥140mmHG and/or DBP ≥90mmHG and/or current intake of BP lowering drugs (Beer-Borst et al., 2018).
[f] Considers the standard plated menu with meat or fish served in the seven intervention organizations/catering facilities on the day of food sampling at t0 or t12.
[g] Salt equivalent (NaCl) = gram sodium (Na) × 2.54.

After the intervention concluded, management, catering, and participant representatives from the eight organizations, and national implementation partners of the FSVO, the federal nutrition policymaking agency, discussed how to integrate nutrition into systemic HP activities and ensure successful, sustainable programs. Extension of this study's findings into practice-based, comprehensive workplace HP programs in Switzerland will require support for tailored workplace HP measures led by corporate management (Della et al., 2008). The Swiss government may also systematically integrate the catering sector and food service suppliers into its reformulation/pledges program (Bundesamt für Gesundheit (BAG), 2018) to increase adoption and long-term effectiveness of combined nutrition interventions (Fitzgerald et al., 2016; Geaney et al., 2011; Geaney et al., 2016) that target well-balanced food choices in which salt is a taste-critical element.

Table 5
Linear regression models after backward selection for changes in salt intake,[a,b] overall and by sex.

Variables	Estimate	95% CI	p-Value	Estimate	95% CI	p-Value	Estimate	95% CI	p-Value
	Overall (n = 119)			Women (n = 60)			Men (n = 59)		
Intercept	−0.4	[−6.4, 5.6]	0.9	0	[−6.8, 6.8]	1.0	8.3	[5.4, 11.2]	< 0.001
Baseline salt intake (g/day)	−1	[−1.2, −0.8]	< 0.001	−1.3	[−1.7, −0.9]	< 0.001	−0.9	[−1.2, −0.7]	< 0.001
Sex (female vs male)	−1.8	[−3.3, −0.2]	0.02	–	–	–	–	–	–
Age (years)	–	–	–	−0.09	[−0.2, −0.004]	0.04	–	–	–
Waist-to-height ratio	19	[7.9, 30]	0.001	26.4	[13.5, 39.3]	< 0.001	–	–	–
Discretionary salt use (no vs yes)	1.3	[−0.03, 2.7]	0.055	1.5	[−0.2, 3.3]	0.08	–	–	–
Adjusted R-squared	0.4438			0.4475			0.4589		

[a] Significance level 0.05.
[b] Salt equivalent (NaCl) intake in g/day, calculated from sodium (Na) excretion in 24-hour urine.

4. Conclusions

This yearlong intervention set in eight Swiss workplaces achieved a reduction of salt intake in women and men that depended on the level of salt intake at study start. The higher the initial salt intake, the greater the reduction. The reduction was greater among men, whose initial mean daily salt intake was over 3 g above that of women, whose mean daily intake at t0 of 7 g was already below the national intermediate salt intake target. This trial established that a workplace program of nutrition education for employees and coaching of catering staff is feasible, and therefore can be a promising approach to healthier eating as workplace HP matures in Switzerland. The RE-AIM evaluation framework highlighted pivotal determinants of low adoption and reach, and program implementation at the catering level. The acceptance, effectiveness, and maintenance of HP research projects—particularly those involving nutrition interventions in the workplace—depend on strong employer support and consideration of environmental factors across settings and sectors. Given a supportive food environment, interventions tailored to sex, age, and CVD risk inter alia could be successful.

Ethics approval and consent to participate

The trial was approved by Swissethics (cantonal ethics committee of Bern KEK BE 130/14, PB_2016_01156) on 11.09.2014. All participating organizations signed a gatekeeper agreement and participants gave informed written consent.

Consent for publication

Not applicable.

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The NRP 69 steering committee evaluated and approved the overall study protocol, and the progress of the research. Neither SNSF/NRP 69 nor SHF were involved in collection, analysis, and interpretation of data, and in writing this manuscript.

Authors' contributions

SBB (principle investigator) and XL drafted the manuscript. XL coordinated the preparation of all relevant information for RE-AIM descriptors by JE, SJ, SS, and SBB. SH conducted analysis. PS provided senior expert input. All authors contributed to the writing of the manuscript, and read and approved the final version.

Availability of data

The datasets generated and/or analyzed during the study are not currently available publicly due to privacy issues. Following completion of our project analyses, data will be available from the corresponding author upon reasonable request.

Declaration of competing interest

The authors declare that they have no competing interests.

PS states that he is an unpaid member of WASH (World Action on Salt and Health) and coordinator of the Interdisciplinary Working Group for Reduction of Salt Intake in Italy (GIRCSI).

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Appendix A. Supplementary data

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