Eight-year Health Risks Trend Analysis of a Comprehensive Workplace Health Promotion Program

Antti Äikäs (anaikas@hotmail.com)
University of Jyväskylä Faculty of Sports and Health Sciences: Jyvaskylan yliopisto Liikuntatieteellinen tiedekunta https://orcid.org/0000-0002-3449-3558

Pilvikki Absetz
University of Tampere Faculty of Social Sciences: Yhteiskunta- ja kulttuuritieteiden yksikko

Mirja Hirvensalo
University of Jyväskylä Faculty of Sports and Health Sciences: Jyvaskylan yliopisto Liikuntatieteellinen tiedekunta

Nicolaas Pronk
HealthPartners Institute

Research

Keywords: workplace health promotion, health risks, effectiveness, implementation, program evaluation

Posted Date: October 2nd, 2020

DOI: https://doi.org/10.21203/rs.3.rs-84173/v1

Version of Record: A version of this preprint was published at International Journal of Environmental Research and Public Health on December 16th, 2020. See the published version at https://doi.org/10.3390/ijerph17249426.

Abstract

Background

This prospective longitudinal quasi-experimental study investigated trends in health risks of a multiyear comprehensive workplace health promotion (WHP) program.

Methods

A comprehensive, eight-year WHP program was implemented emphasizing lifestyle behaviors as key targets in 2010-2013 and environmental supports focused on stress management and mental health resources in 2014-2017. Health risk data was collected from health risk assessments, applying both a questionnaire and biometric screenings. Health risk trends were analyzed for the three time points 2010-2011, 2013-2014 and 2016-2017. Single health risk changes were investigated for three different cohorts using descriptive analyses, t-test, Wilcoxon Signed Rank and McNemar´s test where appropriate. Overall health risk transitions were assessed according to low, moderate and high risk categories.

Results

Trend analyses observed 50-60% prevalence for low, 30-35% for moderate and 9-11% high risk levels across the eight years. In the overall health risk transitions of the three cohorts, 66-73% of participants stayed at the same risk level, 13-15% of participants improved, and 12-21% deteriorated their risk level across the three intervention periods.

Conclusion

Our findings appear to indicate that the multiyear WHP program was effective in slowing the accumulation of measured health risks but fell short of reducing the number of health risks at the population level. In context of expected age-related health risk changes over time, this comprehensive multi-year WHP program was able to generate modest but important shifts in population health risk profiles.

Contributions To The Literature

- Research has shown that workplace health promotion efforts can positively affect health risk accumulation. This long-term, prospective, observational study strengthened the point of view that even while some risks are reduced, others may increase and negate progress on health improvement so that at the population level no change is measured.
- Most of the population (66-73%) stayed at the same risk level, indicating that expectations for short-term health improvement may need to be tempered with respect to permanent risk reduction. However, over the longer-term, positive impact of health promotion programs may be anticipated when the population remains at low risk instead of experiencing increased risk levels as a result of secular trend and aging.

- Our study revealed “successful” and “unsuccessful” subgroups behind population level health risk transitions. From an effectiveness perspective, it would be crucial to identify such groups at an early point of the health promotion design and/or implementation phases.
- Earlier literature has provided insights of health risk changes in the short-term. Such perspectives need to be compared to longer-term observations that can consider the well-known effects of aging on the accumulation of health risks across the human lifespan.Our findings emphasize the aim of keeping healthy people healthy as an appropriate and achievable disease prevention strategy.

Background

A central objective of worksite health promotion (WHP) is to prevent health risk accumulation among the working age population. Earlier, mostly cross-sectional studies indicate that poor employee health is associated with increased medical and pharmacy claim costs [1–4], reduced productivity [5–9] and absenteeism [7, 10].

In response to cross-sectional and observational studies, WHP efforts have been implemented in order to reduce health risks among employees and related research has been conducted that tests the effectiveness of interventions [11]. Reviews have emerged concluding WHP appears to be effective in its objectives to improve health and may also generate a financial return on investment [11–14]. However, there are also studies which have cast doubt on conclusions that WHP programs are effective or cost-effective [15, 16, 17, 18]. Regardless of a scientific effectiveness debate, employers´ interest towards positive impact on health, productivity and return-on-investment has generated a demand for potential WHP solutions [14, 19]. From a health risk management perspective, these efforts should focus on two major objectives: 1) keeping employees in low-risk categories, and 2) moving high-risk individuals into low-risk categories [20].

Several studies [7, 20, 21, 22] have noted the importance of investigating health risk stratification. Health risks may be described as an accumulation of an increased likelihood of illness and disease, which is linked to health behaviors and environments in which individuals participate and engage over the course of their lifespan [23–26]. A person can either be apparently healthy, be at an increased risk level or have multiple health risks and chronic conditions [7, 27]. In the WHP context, risk levels are usually identified with a health risk assessment (HRA) or biometric screening and stratification of health risks is based on the number of risks present [11, 21]. For example, Edington (2001) defined those with zero to two health risks as low risk, three to four as medium risk, and five or more as high risk [21]. Loeppke and colleagues used the Edington´s risk levels in a health risk cohort study of 2606 employees from 2008 to 2009 and categorized 55,7 percent of the population as low risk, 31,1 percent as increased risk, and 13,2 percent as high risk [20].

To summarize the available literature, comprehensive, multiyear programs tend to lower risks in several categories [20, 28, 33], but the slope of such changes is relatively flat [28–30] and also includes negative findings (28, 31–33). Furthermore, the vast majority of studies report results of relatively short intervention periods [11, 20, 29, 30, 32, 33] —especially when considering the context of health risk accumulation as the population ages.

From previous literature we know that context, design process, execution process and evaluation phases provide a framework for effective implementation [7, 12, 34]. A well-designed intervention presents a scalable and sustainable solution that provides intervention dose, target populations, and specific aims that are context relevant [27, 35]. Furthermore, well-executed intervention components include easy access coaching sessions helping participants to learn and maintain healthy behaviors, sufficient participation levels, long-lasting engagement and cost-effective implementation connected with ongoing evaluation [12, 34, 36].

The purpose of this study was to examine long-term health risk trends in response to a comprehensive WHP program. Baseline measurements in 2010 were followed-up over the course of eight years according to two follow-up assessments, one in 2013–2014 and another 2016–2017. A pragmatic in-depth evaluation of this intervention was conducted in the context of scientific dissemination and implementation frameworks and noted successful integration of evidence-informed best practices but also identified improvement potential for a clear path toward sustainability, integration with occupational health care, and support from middle-management supervisors [34, 37]. Furthermore, this comprehensive intervention was observed to achieve *high* penetration and implementation levels, *reasonable* participation rates and *moderate* health impact on the target population during the eight-year-period [38]. Similar prospectively designed, multi-component, multidimensional, and longitudinal evaluations are rare. As a result, the current study complements and adds to the scientific literature from two perspectives:1) What kind of health risk trends can be noticed among all employees across three time points? And 2), did the intervention help to reduce or mitigate health risk accumulation among the study's population during the eight-year period?

Methods

Study Design

This case study focuses on a multi-year health risk evaluation of a WHP in a single company using a prospective, longitudinal quasi-experimental cohort study design without a control group. This study´s reporting protocol followed the STROBE guidelines (see additional file 1). Health risk trends measurements were made for three time points representing the periods 2010—2011, 2013—2014, and 2016—2017, respectively. Trend analyses investigated the prevalence of health risks at each of these measurement points. Cohort analyses considered participants´ health risk changes during three different implementation periods from 2010 to 2013, from 2014 to 2017 and from 2010 to 2017, respectively. Similar trend and cohort analyses methods have been used by Byrne and colleagues (2011) and Loepkke and colleagues (2010) [20,31].

Intervention

A comprehensive intervention (ENSO) was delivered over an eight-year period from 2010 to 2017 in a Finnish wood supply company, Stora Enso Metsä. The organization´s main focus was to buy, harvest and transport wood for Stora Enso mills throughout the nation. At the beginning, the employer had altogether over 100 business units nationwide and over six hundred employees, which were the participants of the program. Subcontractors and family members were not in a target population. The Enso program was a tailored version of a comprehensive WHP concept designed and produced by the provider of the program, 4event Ltd. The ENSO program can be classified as a comprehensive program, including all five elements that are based on the Healthy People 2010 definition: health education, supportive environment, integration into organization´s structure, linkage to related programs and worksite screening [39].

The primary focus of ENSO was to improve the health and well-being of every employee and the intervention and its services have been described earlier in detail [37-38]. Noteworthy, the intervention´s very first four years emphasized low-effort, pleasant lifestyle changes, nutrition and physical activity, whereas the last four years concentrated more on the environmental context emphasizing workplace climate, stress management and mental resources [37-38]. The midpoint shift in major content enabled us to study different implementation impacts on the three cohorts. See further information about implementation components in Additional file 2.

Participants

Each year all employees of Stora Enso Metsä were participants of the program. Most participants were white-collar workers, i.e., executives, local forest officers, organization officials and a smaller proportion were blue-collar workers, i.e., lumberjacks and terminal workers in the organization´s units connected into Stora Enso's eight paper mills in Finland. The total number of participants progressively declined during the course of the study as follows: 651, 634, 630, 625, 530, 526, 523, and 523 during the years 2010 through 2017, respectively. The largest drop in the total number of staff happened in 2014, when statutory labour negotiations took place and, as a result, the local forest officers and lumberjacks in Western Finland were no longer a part of the company. Due to the fact that the drop in total participant number might have had an influence on health risks trend over time, we tested for differences between baseline results among follow-up HRA participants compared to participants at baseline only (Additional file 3). The tests show clearly that employees who took part only at baseline were older ($p<0.000$), had more health risks ($p<0.001$) and were less likely to belong to the low health risk group ($p<0.020$) than multi-year HRA participants. Every employee, despite whether they participated in assessments of health risks, was provided free access to the ENSO program.

Data Collection

Every employee was invited to participate in assessments of health risks (HRA) in 2010-2011, 2013-2014 and 2016-2017. The HRA consisted of a questionnaire and biometrical screenings, which participants completed at the same time. The biometric part of assessments was executed with a transferable Polar

BodyAge^{TM} system so that mapping was offered close to the participants´ workplaces and multiple occasions could be offered throughout the day and measurement period.

The questionnaire included demographic items (age, gender, location, personnel group) and items related to physical activity, lifestyle change, weight management, musculoskeletal disorders and mental resources. The questionnaire was a combination of questions from an annual national survey Health Behaviour and Health among the Finnish Adult Population, Polar Body Age test protocol, the stages of transtheoretical model, the service provider´s own questions and employer's own questions [40-43].

The health risk information was pooled from items listed in TABLE 1. The final data consisted of eight variables which were included in each data collection point and four additional important health risk variables (e.g., smoking) which were available only at follow-up one and follow-up two.

The actual health risk definition was based on a simple 0 or 1 taxonomy, a participant either having or not having a risk. For example, physical inactivity was asked using a four-point Likert scale (low, moderate, high, very high) and a sedentary job and minimal exercise per week portrayed the *low* criteria and ascribed a *risk*. For a vitality measurement, participants were asked to select one option from a five-point scale starting from "I seldom feel energetic and vital" ending up to "I feel energetic and lively every day". The lowest possible answer "seldom" was assigned a risk. In similar self-reporting manner, chronic pain and stress and alcohol usage were asked using a five-point Likert scale: 1) totally disagree 2) disagree 3) neutral 4) partly agree 5) totally agree. A high level of health risk was considered by only including "totally agree" options when indicating chronic pain and stress risk. However, alcohol usage was considered risky behaviour if a respondent selected either four or five. Comparatively, musculoskeletal disorders (MSD), medication for cardiovascular disease and regular smoking were simple yes/no statements, in which the "yes" answers determined a status of a health risk. Absences due to MSD were counted as a risk if person reported being away from work four or more days due to MDS during the last twelve months.

A similar simple taxonomy was used in biometrical health risk screenings. The cardiovascular fitness classification was based on the seven-point scale by Shvarts and Reibold (1990), where results from very low to low were assigned as a health risk [44]. High blood pressure was categorized as a health risk if a person's systolic blood pressure was over 139 mmHg or diastolic pressure was over 89 mmHg. A limit value for high body mass index (BMI) has varied in earlier studies, hence criteria previously used in well-known studies in the WHP field that stem from the National Institutes of Health in the US, ≥ 27.8 kg/m^2 for men and ≥ 27.3 kg/m^2 for women, were deployed in this study [20,21].

ETHICAL ISSUES

This study followed the ethical principles of the University of Jyväskylä and the research guidelines provided by the National Advisory Board on Research Ethics in Finland [45]. The employer and all the employees provided an informed consent for this research. The protocol of the study with an informed consent form was included in the HRA remapping questionnaire both in 2013-2014 and 2016-2017 and handed out to each employee. Participation in this research, as well as giving authorization to use the earlier results of assessments of health risks, was entirely voluntary. The health risk data collected was managed by the researcher and entered into SPSS 26.0 for statistical analysis.

DATA ANALYSIS

Eligible employees were selected from the health risk analysis database using two inclusion criteria. First, an employee had to have participated in both health risks assessments (the biometrical screenings and the questionnaire). Second, an employee had to have data for at least six-out-of-eight or nine-out-of-twelve risk variables depending on the data collection period used. In case of missing data, no statistical replacement methods were used.

Data on health risk trends were analysed at three different time points to represent the prevalence of health risks among the population, with eight health risks at the baseline in 2010-2011 and twelve health risks in 2013-2014 and 2016-2017. Health risk trends were compared descriptively, including percent point difference, count difference or average difference.

To investigate health risk changes during the intervention, three cohorts were utilized. Cohort1 from 2010 to 2013 represented the first half of the eight year intervention (n=359), whereas cohort2 from 2014 to 2017 represented the latter half (n=255). Finally, cohort3 from 2010 to 2017 represented the entire period (n=253). The cohorts were relevant for this study, since they represented different intervention periods and were also used in our earlier study, where we investigated implementation coefficients of each of the periods and overall effectiveness of the same comprehensive program [38]. It should be noted that the cohorts were not independent samples, as 215 persons took part in all three assessments (see additional file 4).

We investigated not only changes of single health risk variables, but also individual level improvements or reductions in health risk total number. With this in mind, more detailed analyses were completed for the three cohorts in order to investigate total health risk accumulation in different subgroups (sex, age and personnel group). We also included a subgroup analysis of “successful” and “unsuccessful” participants, which were classified in our earlier study [38]. A participant was considered to be successful if she/he met two clear criteria. First, that the person answered YES to the question “Have you made a lifestyle change during the program?”, and chose at least one from a list of nine lifestyle change options. Second, the person’s biometric health parameters had to have been improved based on the Body Age biometric screening [38].

Edington (2001), Loeppke (2010) and Byrne et al (2011) defined overall risk levels as follows: low (0–2 high risks), moderate (3–4 high risks), and high (5 or more risks)[20-21]. However, we used cut-off points 0-1 for low, 2-3 for moderate and 4 or more for high risk levels. The reason for using these more stringent categories is based on our data collection approach that included only eight and twelve health risks, whereas the comparison studies used fifteen. We explored the overall risk levels (low, moderate and high) in the trend and cohort analyses to summarize health risk prevalence among participants. Furthermore, in the final analyses of this study the transitions between low, moderate and high risk levels were described with the following categories, improved, unchanged or deteriorated. For example, a person was classified as “deteriorated” if she/he moved from low risk level into moderate or high risk group.

Statistical analyses included descriptive statistics, paired samples t-test, Wilcoxon Signed-Rank and McNemar´s test where appropriate. Significance of the results was reported at .05, .01 or .001 levels.

Results

Table 2 describes the demographics and health risk trends at baseline and two follow-up measurements among the study population. At baseline ~ 90% percent of attended health risk assessment, ~ 81% at the first follow-up and ~ 69% at the second follow-up. In the first follow-up, the drop-out reflected net reduction of total number of staff, but not anymore at second follow-up. As an overview, the populations participating HRA data were for the most part equivalent between three time points. The mean age stayed almost the same between three different time points, yet the proportion of the age group ≤ 35 years and 46–55 years lost it share. From an occupational perspective, local forest officers were the largest personnel group each time and lumberjacks were not a part of organization and analysis after the first follow-up.

According to trend analysis, the average number of health risks was 1.49 at baseline, 1.41 at follow-up one and 1.30 at follow-up two, when the calculation constituted eight health risks. As the number of measured health risks altered from the baseline´s eight to follow-ups´ twelve, the average number of health risks increased to 1.59 at follow-up one, but at the same level (1.30) at follow-up two.

Prevalence of single health risks varied from 0.2 to 8.8 percent points between baseline, follow-up one and follow-up two. When comparing the follow-up trends against baseline, reduced risk levels were noted in physical inactivity, low cardiovascular fitness, high blood pressure, high BMI, smoking and daily alcohol usage. In contrast, prevalence of musculoskeletal disorders (MSD), four or more illness days due to MSD, mediation for cardiovascular disease, low vitality, chronic pain and self-reported stress stayed the same or increased.

A relevant finding for this study was that the distribution of overall risk levels was relatively stable showing only slight variations in the low risk (~ 55–60%), moderate risk (~ 30–35%), and high risk (~ 9–11%) categories, respectively. To summarize the trend analysis, the three cross-sectional populations analysed were quite similar from a health risk trend perspective, although slight differences were found in the age group distribution, personnel groups, and among single health risk variables.

In Table 3, health risk changes are reported for the three study cohorts. Overall, the changes in all three cohorts are small, which is a parallel finding with the results of the health risk trend analysis. Unique to this analysis, there was increase in medication for cardiovascular disease during the entire program, and significant changes were observed in all three cohorts ($p < 0.05$). Likewise, a relatively large increase was found in self-reported musculoskeletal disorders in the cohort1 ($p = 0.001$), but the change faded in cohort2 and in cohort3. The prevalence of high BMI increased in cohort3 ($p = 0.023$), though statistically significant BMI changes were not documented either in the cohort1 or in the cohort2. Altogether, negative changes were noted in four out of eight variables in the cohort1 and six out of twelve in the cohort2 and four out of eight in the cohort3. However, most of these changes did not reach statistically significant differences.

More detailed results for health risk accumulation in the three cohorts and different subgroups are presented in additional files 5, 6 and 7. These subgroup analyses based on sex, age group, personnel group and successful / unsuccessful population comparisons. In general, the average number of risks was higher in age groups 46–55 years and ≥ 56 years, among terminal workers and lumberjacks in all cohorts, and among men in the cohorts 1 and 2. Furthermore, the average number of health risks was low (less than 2 risks) and tended to grow slightly in most subgroups during the four- and eight-year follow-up periods.

In the paired samples analysis, statistically significant risk reduction was found in a "successful group" in the cohort 1 from 2010 to 2013 (1.33 ± 1.36 to 1.13 ± 1.18, $t = 1.984$, $p < 0.05$). On the contrary, risk increase was documented in "unsuccessful group" (1.33 ± 1.24 to 1.65 ± 1.41, $t=-4.278$, $p < 0.001$), among men (1.39 ± 1.31 to 1.56 ± 1.35, $t=-2.680$, $p < 0.01$) and among local forest officers (1.26 ± 1.12 to 1.43 ± 1.36, $t=-2.244$, $p < 0.05$). These analyses confirmed our categorization of successful and unsuccessful participants. In contrast, statistically significant changes were rare in the other two cohorts. For instance, we did not find any significant subgroup changes in cohort 2 from 2014 to 2017. And the only significant change in cohort 3 from 2010 to 2017 was the unsuccessful group´s increase in the number of risks (1.16 ± 1.16 to 1.54 ± 1.37, $t=-4.235$, $p < 0.001$).

Figure 1 depicts overall risk levels changes for the three cohorts. At the starting point of each period the proportion of *low risk* participants was slightly higher than in the earlier trend analysis variating from 58.4 percent to 67.6 percent. Corresponding values for moderate- and high-risk populations were between 25.3–33.0% and 7.0-8.6% respectively. The transitions between low, moderate and high-risk populations were very similar in Cohort1 and in Cohort3. In these cohorts the proportion of participants who stayed at the same risk level was equal (66%) and the amount of deteriorated participants (19–21%) was slightly larger than improved participants (13–15%). On the contrary in the cohort two, 15% of participants managed to improve their overall health risk level against 12% of deterioration, while most of the participants stayed in the unchanged population with a proportion of 73 percent.

More specifically, the most common groups in the analysis clearly represented employees who stayed at the low risk level (47.4–53.4%) or at the moderate risk level (10.3–16.5%). If a participant shifted between risk levels, then the majority of transitions was observed either from low to moderate or moderate to low level across the three cohorts. The transitions from or into the high-risk population were small.

Discussion

This study investigated health risk trends and participants' health risk transitions between low, moderate and high risks categories during an eight-year comprehensive workplace health promotion program. A relevant aspect of this study was that the program´s implementation was split at the halfway point of the study. The first part included a focus on more traditional behavior change approaches whereas the latter part focused more on workplace environment and culture and included support for mental health resources. The major content change and three different measurement time-points created a unique ground for this study.

Understanding health risks is important from a health promotion perspective, since they are the source of many non-communicable diseases, loss of healthy and productive years, and a causal factor for increased health care expenses all over the world [7, 23, 25–27]. Hence, there are two clear aims for health promotion interventions: 1) to keep healthy employees healthy, and 2) to move high-risk individuals into lower-risk categories [7, 20].

A major finding of this study was that it substantiated the first aim but failed to achieve the second aim. The overall health risks levels stayed level meaning that the majority of the population, both in the trend and cohort analysis, were in the low and moderate risk category and stayed there. Furthermore, the three cohort analyses revealed that, if there were transitions between risk levels, the most common changes took place between low and moderate groups, i.e., movement from or into high risk population was rare.

As it comes to health risk reduction and moving high risk population into moderate or low risk category, five important observations are highlighted based on this study. First, the prevalence of measured health risks was lower than in an average working-age population. For example, prevalence of overweight, physical inactivity, low cardiovascular fitness, high stress and smoking were clearly lower than in the benchmark literature [27, 28, 31, 40]. In addition, the similarity test showed that a healthier and younger part of employees took part HRA assessments. This is of course a good premise from a maintenance perspective but might have contributed to a floor effect when considering the aim to reduce health risks. Furthermore, the trend analysis of single health risk variables revealed that high blood pressure and high BMI were common (> 30%), every fifth or fourth employee had musculoskeletal disorders (> 20%) and physical inactivity was quite common at baseline (~ 20%), but all other health risks considered were quite less common (< 10%). These findings help us understand why health risk assessment participants showed a relatively low number of 1.3–1.5 risks per person and why most of the health risk transitions were observed between the low and moderate risk categories.

Second, even though this intervention program was able to exert a moderate impact on biometrical health and fitness variables [38], the program was not able to influence health risk variables in a similar manner. For instance, the prevalence of medication for cardiovascular disease was not part of this intervention but was noted to increase in all three cohorts. It is also possible that some of the health risks were derived from permanent individual or environmental issues that were not part of this study´s health promotion efforts. These might include, for example, prevalence of musculoskeletal disorders, chronic pain and self-reported stress, which stayed the same or increased in the trends or follow-ups.

Third, we decided to use clearly defined cut-off points, 0–1 risks for low, 2–3 risks for moderate and 4 or more risk for high risk levels due to the fact that our data collection consisted only of eight and twelve health risk variables. Other benchmark studies have used fifteen [20–21]. Interestingly, our health risk trend observations for low (~ 55–60%), moderate (~ 30–35%) and high risk population (~ 9–11%) were at a similar level as reported by Loeppke et al (2010) who deployed less stringent limits and found positive health risk reductions [20]. In this study, however, our classification scheme may have caused a lower likelihood to see the impact of the intervention since tighter limits also mean a need for stronger impact to move participants into lower health risk levels.

The fourth observation relates to aging. It is a well-known fact that the number of health risks tend to increase with aging [23, 25, 26]. Our sub-group analysis supported this notion. The cohort analysis of eight-year continuum did not contain major deterioration nor improvements in health risks. According to the Natural Flow model by Edington (2001) it is expected that 61% of the population would maintain their risk level, 23% end up to a worse level and only 16% to improve [21], but the model does not reflect benchmark values for longer follow-ups. In this sense our findings show encouraging results to counter-balance the effects of aging on health risk accumulation.

The fifth and final observation refers to the health risk accumulation in different sub-groups (Additional files 5–7). In the 2010–2013 and 2010–2017 cohorts, we found statistically significant differences in men, executive, local forest officer, unsuccessful and successful groups when using paired samples t-test. These subgroup findings give a reason to expect that some employees did not take advantage of the program's support or were not able to achieve permanent healthier lifestyles nor avoid an increasing number of health risks. As a future recommendation, it would be of substantial interest to identify proactive means of engagement of those individual who belong to “successful” and “unsuccessful” groups at an early point of implementation in order to optimize positive impact on health risks. This kind of course-correction methods have been supported by several researchers and include the notion of feedback loops in program design as exemplified by the so called 4-S model, which was used as a design evaluation tool in our first study [35, 37]

This study followed the same population going through two phases of the study. The first four years were implemented with intervention programs emphasizing behaviour change whereas the next four years were implemented with more of an emphasis on the workplace environment. A bit surprisingly, more positive observations were found in overall health risk stratification during the second four years, even though the period had the lowest overall health impact according to our earlier study [38]. This discrepancy most likely ensued from the data collection of the second four years, which consisted of twelve health risk variables and thus gave more opportunities for improvement.

Our findings from the three cohorts reported 66–73% of participant maintaining, 13–15% of improvement and 12–21% deteriorating in overall risk levels. Earlier one-year intervention studies also reported such population health risk shifts, such as the study by Loeppke et al (2010) that reported 68% unchanged, 23% improved and 9% worsened and a two-year intervention study by Pronk (2014) that noted 66% no-change, 21% improved, and 13% deteriorated [20, 46]. These observations lead us to speculate on *what* *would have enhanced* the impact of this study's specific long-term program on the reduction of health risks during the implementation?

One point of view is that the content of the program should have been focused more directly on employees who experienced the health risks targeted by the program. Instead, the main focus of the program was on themes which were most likely suitable for everyone (i.e., nutrition, physical activity, workplace culture). If done so, it might have increased the "effectiveness" of targeted services, but at the same time it might have reduced the level of participation because the prevalence of health risks was mostly less than < 30% and usually employees with more severe health risks are the least likely ones to participate [36]. Furthermore, it should be kept in mind that our earlier findings indicated a reasonable participation rate that was sufficient to produce impact [38].

Another perspective would have been to focus more strongly on the high risk population. This approach is supported by well-documented observations that financial savings come from managing diseases [14, 29, 47, 48]. Yet, this notion may be challenged by the point of view stating that it is important to target the group with the highest costs while also offering program opportunities to those employees who are at medium or low risk levels [7, 49]. However, our analysis did not investigate these matters at this point, yet future research should evaluate financial data to justify the decisions that support comprehensive WHP programming.

Another potential improvement opportunity would have been closer co-operation with occupational health care. Our first study noted that a closer relationship was pursued, but not achieved in 2012, and it would have been a valuable resource in managing health risks especially in the high risk group since at least some of the risks measured in this study must have been registered also during health care appointments [37]. Likewise, other implementation studies have supported the aspect of co-operation in order to reach program´s objectives [50].

This study had several limitations that should be noted. The current study lacked a control group and the results and findings should be considered in a quasi-experimental context. The data collection consisted of eight and twelve health risk variables, whereas some benchmark studies have used as many as fifteen. In addition, the data collection did not offer blood tests, which are commonly used to identify health risks, e.g., high cholesterol and fasting blood glucose. Finally, the workforce was mostly male- and white-collar. Similar results might not be observed in a more gender-balanced or among a low wage workforce.

Balanced against the noted limitations, this study also showed several major strengths. Notably, its eight-years duration, three different measurement points, and health risk assessments including both biometrical and questionnaire data—all these data provided for a unique database for analysis. Furthermore, this study investigated the health risk changes in a real-world context with a long-term research effort and complemented the earlier design and implementation analysis of the same comprehensive program [37–38].

Conclusion

In summary, this study's results show that the accumulation of health risks as a function of aging was stopped, but not reduced in a mostly male employee population over an eight-year period. The reasons behind succeeding in one aim and failing in another were multidimensional. Our findings indicate the difficulty to lower health risks at the organizational level, particularly when the prevalence of health risks is not high and if there are subgroups who do not engage with health promotion efforts. However, our findings agree with earlier literature that a comprehensive WHP program can affect the employees´ health and slow health risk accumulation compared to a situation where no intervention is provided [7, 20–22, 28, 32]. Future research should investigate the reasons behind “unsuccessful” group in order to lift the effectiveness of health risk prevention plans. And finally, even though this study´s intervention has been analysed from several implementation perspectives, an economic analysis is needed to complete the overall evaluation.

Abbreviations

WHP
Workplace Health Promotion
HRA
Health Risk Assessment
BMI
Body Mass Index
MSD
musculoskeletal disorders, i.e., low back pain, knee problems
ENSO
The name of the study´s comprehensive WHP program

Declarations

ETHICS APPROVAL AND CONSENT TO PARTICIPATE

This study was established according to the ethical principles of the University of Jyväsylä and the research quidelines provided by the National Advisory Board on Research Ethics in Finland. The employer and all the employees provided an informed consent for this research. The protocol of the study with an informed consent form was included in the HRA remapping questionnaire both in 2013-2014 and 2016-2017 and handed out to each employee. Participation in this research, as well as giving authorization to use the earlier results of assessments of health risks, were voluntary.

AVAILABILITY OF DATA AND MATERIALS

The data that support the findings of this study are available from 4event ltd and Stora Enso Metsä corporation, but restrictions apply to the availability of these data, which were used under licence for the current study, and so are not publicly available. All data generated or analysed during this study are included in this published article and its supplementary additional files.

COMPETING INTEREST

The corresponding author (AÄ) was an employee of 4event Ltd, which designed and implemented the study's worksite health promotion program. Pilvikki Absetz has kept two single team workshops for 4event Ltd during 2013 to 2015; the participants (10 to 20 persons) were employee of Stora Enso Metsä. Other declare that they have no competing interests.

FUNDING

Juho Vainio foundation, Finland, supported financially the manuscript writing process. Urheiluopistosäätiö, Finland, supported financially the data

collection and analysis.

CONSENT FOR PUBLICATION: Not applicable

AUTHOR´S CONTRIBUTIONS

AÄ analyzed and interpreted the health risk data. MH, PA and NP were major contributors in writing the manuscript. All authors read and approved the final manuscript.

ACKNOWLEDGEMENTS

The authors thank Jouni Lahti, PhD, Adjunct Professor, Department of Public Health, University of Helsinki, for doublechecking the health risk assessments data.

References

1. Goetzel R, Anderson D, Whitmer R, Ozminkowski R, Dunn R, Wasserman J. The relationship between modifiable health risks and health care expenditures: An analysis of the multi-employer HERO health risk and cost database. J Occup Environ Med. 1998;40:843–54.
2. Yen L, McDonald T, Hirschland D, Edington DW. Association between wellness score from a Health Risk Appraisal and prospective medical claims costs. J Occup Environ Med. 2003;45:1049-57
3. Burton WN, Chen CY, Conti DJ, Schultz AB, Edington DW. Measuring the relationship between employees'health risk factors and corporate pharmaceutical expenditures. J Occup Environ Med. 2003;45:793-802.
4. Musich S, White J, Hardley S, Bhattarai G, Hawkins K, Ozminkowski R. A more generalizable method to evaluate changes in healthcare costs with changes in health risks among employers of all sizes. Popul Health Manag. 2014;17:297–305.

5. Schultz AB, Edington DW. The association between changes in metabolic syndrome and changes in cost in a workplace population. J Occup Environ Med. 2009;51:771–9.
6. Aldana SG, Pronk, NP. Health promotion programs, modifiable health risks, and employee absenteeism. J Occup Environ Med. 2001;43:36–46.
7. Schultz AB, Edington DW. Employee health and presenteeism: a systematic review. J Occup Rehabil. 2007;17(3):547-79.
8. Boles M, Pelletier B, Lynch W. The relationship between health risks and work productivity. J Occup Environ Med. 2004;46:737–45.
9. Burton WN, Conti DH, Chen CY, Schultz AB, Edington DW. The role of health risk factors and disease on worker productivity. J Occup Environ Med. 1999;41:863–77.
10. Burton WN, Chen CY, Conti DJ, Schultz AB, Edington DW. The association between health risk change and presenteeism change. J Occup Environ Med 2006;48:252–63.
11. Soler R, Leeks K, Razi S, Hopkins D, Griffith M, Aten A, et al. A systematic review of selected interventions for worksite health promotion. The assessment of health risks with feedback. Am J Prev Med. 2010;38(2 Suppl):S237–62.
12. Goetzel R, Henke R, Tabrizi M, Pelletier K, Loeppke R, Ballard D, et al. Do workplace health promotion (wellness) programs work? J Occup Environ Med. 2014;56:927–934.
13. Goetzel RZ, Ozminkowski RJ. The health and cost benefits of work site health-promotion programs. Annu. Rev. Public Health 2008;29:303–23
14. Baicker K, Cutler D, Song Z. Workplace wellness programs can generate savings. Health Affairs. 2010;29:304–11.
15. Reif J, Chan D, Jones D, Payne L, Molitor D. Effects of a Workplace Wellness Program on Employee Health, Health Beliefs, and Medical Use. JAMA Intern Med. Published online May 26, 2020. doi:10.1001/jamainternmed.2020.1321
16. Song Z, Baicker K. Effect of a workplace wellness program on employee health and economic outcomes - A randomized clinical trial. JAMA. 2019;321(15): 1491-1501. doi:10.1001/jama.2019.3307
17. Mattke S, Liu H, Caloyeras J, Huang C, Van Busum K, Khodyakov D, et al. Workplace Wellness Program Study: Final Report. 2013. Santa Monica, CA: RAND.
18. Osilla K, Van Busum K, Schnyer C, Larkin J, Eibner C, Mattke S. Systematic review of the impact of worksite wellness programs. Am J Manage Care. 2012;18:e68–81.
19. Abraham J. 2020. Taking stock of employer wellness program effectiveness—Where should employers invest? Published online May 26, 2020. doi:10.1001/jamainternmed.2020.1402.
20. Loeppke R, Edington D, Bég S. Impact of the prevention plan on employee health risk reduction. Popul Health Manag. 2010;13: 275–84.
21. Edington DW. Emerging research: a view from one research center. Am J Health Promot. 2001;15:341–49.

22. Blake H, Zhou D, Batt M. 2013 Five-year workplace wellness intervention in the NHS. Perspectives in Public Health Vol. 133(5)
23. Ezzati, M; Lopez A, Rodgers A, Vander Hoorn S, Murray C. Selected major risk factors and global and regional burden of disease. The Lancet. 2002;360: 1347-60 https://doi.org/10.1016/S0140-6736(02)11403-6
24. McInnis J, Williams-Russo P, Knickman J. The case for more active policy attention to health promotion. Health Affairs. 2002:21(2)
25. Danaei G, Vander Hoorn S, Lopez A, Murray C, Ezzati M. Causes of cancer in the world: comparative risk assessment of nine behavioural and environmental risk factors. The Lancet, 2005:366;1784-93 https://doi.org/10.1016/S0140-6736(05)67725-2
26. World Health Organization. Preventing chronic diseases: a vital investment. Geneva: World Health Organization; 2005. Available from: http://www.who.int/chp/chronic_disease_report/full_report.pdf
27. O´Donnell, M. Health promotion in the workplace 5th edition. 2017. Art & Science of Health Promotion Institute.
28. Henke R, Goetzel R, McHugh J, Isaac F. Recent experience in health promotion at Johnson & Johnson: lower health spending, strong return of investment. Health Affairs. 2011;30:490–9.
29. Nyman J, Abraham J, Jeffery M, Barleen H. The Effectiveness of a health promotion program after 3 years. Evidence from the University of Minnesota. Med Care 2012;50: 772–8.
30. Yen L, Edington M, McDonald T, Hirschland, Edington D. Changes in health risks among the participants in the United Auto Workers–General Motors LifeSteps health promotion program. Am J Health Promot. 2001;16(1):7-15.
31. Byrne D, Goetzel R, McGown P, Holmes M, Beckowski M, Tabrizi M, et al. Seven-year trends in employee health habits from a comprehensive workplace health promotion program at Vanderbilt University. J Occup Environ Med. 2011;53(12):1372–81.
32. Gold D, Anderson D, Serxner S. Impact of a telephone-based intervention in the reduction of health risks. Am J Health Promot. 2000;15:97–106.
33. Goetzel R, Ozminkowski R, Bruno J, Rutter K, Isaac F, Wang S. The long-term impact of Johnson & Johnson's health & wellness program on employee health risks. J Occup Environ Med. 200; 44:417–24.
34. Pronk N. Best practice design principles of worksite health and wellness programs. ACSM Health Fitness J. 2014;18:42–46.
35. Pronk N. Designing and evaluating health promotion programs: simple rules for a complex issue. Dis Manage Health Outcomes. 2003;11:149–57.
36. Robroek SJ, van Lenthe FJ, van Empelen P, Burdorf A. Determinants of participation in worksite health promotion programmes: a systematic review. Int J Behav Nutr Phys Act. 2009;6:26.
37. Äikäs A, Pronk N, Hirvensalo M, Absetz P. Does Implementation follow design? A Case Study of a Workplace Health Promotion Program Using the 4-S Program Design and the PIPE Impact Metric

Evaluation Models. J Occup Environ Med. 2017;8:752-60.

38. Äikäs A, Absetz P, Hirvensalo M, Pronk N. What Can You Achieve in Eight Years? A Case Study on Participation, Effectiveness, and Overall Impact of a Comprehensive Workplace Health Promotion Program. J Occup Environ Med. 2019;61(12):964–77
39. Linnan L, Bowling M, Childress J, Lindsay G, Blakey C, Pronk S, et al. Results of the 2004 national worksite health promotion survey. Am J Public Health. 2008;98:1503–1509.
40. Helakorpi S, Pajunen T, Jallinoja P, Virtanen S, Uutela A. National Institute for Health and Welfare Report 15. Health Behaviour and Health Among the Finnish Adult Population, Spring 2010. Helsinki, Finland; 2011
41. Polar Electro Ltd. Polar BodyAge HRA assessment. Available at: https://support.polar.com/e_manuals/BodyAge/Polar_BodyAge_user_manual_English.pdf. Accessed January 3, 2020.
42. Prochaska J, Velicer W. The transtheoretical model of health behavior change. Am J Health Promot. 1997;12:38–48.
43. 4event Ltd. HRA questionnaire for Stora Enso Metsä Corporation 2010-2017. Lahti. Finland. 2010.
44. Shvartz E, Reibold R. Aerobic fitness norms for males and females aged 6-75 years: a review. Aviat Space Environ Med. 1990;61:3–11.
45. University of Jyväskylä. Ethical Principles of University of Jyväskylä. Available at: https://www.jyu.fi/en/research/doctoral-studies/guide/ethics Accessed January 1, 2020.
46. Pronk N. Primary prevention and health promotion at the workplace. Making things visible. ACSM. 2014:18:38-9.
47. Caloyeras J, Liu H, Exum E, Broderick M, Mattke S. Managing manifest diseases, but not health risks, saved PepsiCo money over seven years. 2014;33:124-31.
48. Chapman L. Meta-evaluation of worksite health promotion economic return studies: 2012 update. Am J Health Promot. 2012;26:TAHP1–TAHP12.
49. Roberts, S. New approach addresses root causes of illnesses. Business Insurance. 2005; https://doi.org/10.1177/216507990505300705
50. Hudson, H.L., Nigam, J.S., Sauter, S.L, Chosewood, L.C., Schill, A.L., & Howard, J. (Eds.) Total Worker Health. Washington, DC: American Psychological Association, 2019.

Tables

TABLE 1. Health risks and definitions

Health risk	Time points*	Measurement	Source	Definition of high risk**
Physical inactivity	B,F1,F2	Questionnaire	self-reported	“Low” responses to a four-point (low, moderate, high, top) self-reported physical activity level during the last six months. The description of the “low” was set as follows: . - *“At work you sit most of the day or your work does not require much physical effort.* - *“Your daily exercise is minimal (0—1 times per week) and you walk rarely.”* - *“You seldom sweat or become breathless during exercise.”*
Low cardiovascular fitness	B,F1,F2	Biometric screening	Measured submax test VO_{2max} in ml/kg/min and categorized	1 (very Low) or 2 (low) cardiovascular fitness in 7 point scale by Shvarts and Reibold 1990 [44]
High blood pressure	B,F1,F2	Biometric screening	Measured mmHg	Systolic ≥140 or diastolic ≥ 90
High BMI	B,F1,F2	Biometric screening	Measured weight (kg) and height (m) and expressed as kg/m^2	≥ 27.8 kg/m^2 men, ≥ 27.3 kg/m^2 women
Low vitality	B,F1,F2	Questionnaire	self-reported	“Yes” to *“I seldom feel energetic and vital.”*
Musculoskeletal disorder	B,F1,F2	Questionnaire	self-reported	“Yes” to *“Do you have musculoskeletal problems or injuries that prohibit you from exercising?”*
Illness days due to MSD	B,F1,F2	Questionnaire	self-reported	“4 or more days” to *‘Have you been missed from work due to MSD illness during the past 12 months?”*
Medication for cardiovascular disease	B,F1,F2	Questionnaire	self-reported	“Yes” to *“Are you on medication for high blood pressure or for heart disease?”*
Chronic pain	F1,F2	Questionnaire	self-reported	“5 - totally agree” to a five-point Likert scale statement *“I have chronic pain.”*
Chronic stress	F1.F2	Questionnaire	self-reported	“5 - totally agree” to a five-point Likert scale statement *“I repeatedly suffer from stress.”*

Regular smoking	F1,F2	Questionnaire	self-reported	“Yes” to *“Do you smoke regularly?”*
Daily alcohol	F1.F2	Questionnaire	self-reported	“5 – totally agree or 4 - partly agree” to a five-point Likert scale statement *“I use alcohol on a daily basis.”*

*B=baseline 2010-2011, F1=Follow-up 2013-2014, F2, Follow-up 2016-2017

**Each health risk factor was assigned a value of 1 if the definition was met, otherwise it was assigned a value of 0

TABLE 2. Health Risk Trends at Three Different Time Points

	Baseline 2010-2011	Follow up 1 2013-2014	Follow up 2 2016-2017	Difference *BL® F1*	Difference *BL® F2*	Difference *F1® F2*
Participants						
Total employees	651	530	523	-121	-128	-7
HRA participants	90.3%	81.3%	69.4%	-9.0	-20.9	-11.9
Percent males	83.5%	82.6%	80.8%	-0.9	-2.7	-1.8
Mean age (yrs)	43.8	45.1	44.2	+1.3	+0.4	-0.9
Percent ≤ 35 years	30.4%	25.8 %	26.7 %	-4.6	-3.7	+0.9
Percent 36-45 years	17.5%	19.1 %	25.3 %	1.6	7.8	+6.2
Percent 46-55 years	37.1%	34.2 %	29.5 %	-2.9	-7.6	-4.7
Percent ≥ 56 years	15.0%	20.9 %	18.5 %	+5.9	+3.5	-2.4
Personnel Group						
Executives	14.8 %	22.7 %	20.1 %	+7.9	+5.3	-2.6
Local forest officers	46.8 %	49.2 %	55.4 %	+2.4	+8.6	+6.2
Officers	18.7 %	14.2 %	10.7 %	-4.5	-8.0	-3.5
Terminal workers	12.1 %	9.7 %	13.8 %	-2.4	1.7	+4.1
Lumberjacks	5.8 %	4.2 %	-	-1.6	-5.8	-4.2
NA	1.9 %	-	-	-1.9	-1.9	-
Health risks						
Physical inactivity	20.4 %	15.7 %	15.9 %	-4.8	-4.6	+0.2
Low cardiovascular	8.1 %	5.2 %	6.4 %	-2.8	-1.7	+1.2

fitness	39.9 %	36.3 %	31.1 %	-3.5	-8.8	-5.2
High blood pressure	38.3 %	33.0 %	35.2 %	-5.2	-3.1	+2.2
High bmi	1.6 %	1.9 %	2.5 %	+0.3	+1.0	+0.6
Low vitality	21.8 %	26.8 %	20.6 %	+5.0	-1.2	-6.2
Musculoskeletal disorder	7.2%	9.1%	7.2%	+1.9	0.0	-1.9
Illness days due to MSD	12.2 %	14.7 %	12.0 %	+2.4	-0.2	-2.6
Medication for cardiovascular disease						
Chronic pain		3.1 %	3.4 %			+0.3
Chronic stress		2.8 %	5.1 %			+2.3
Smoking		9.8 %	9.3 %			-0.5
Alcohol		2.4 %	1.1 %			-1.2
Total sum of (8) health risks	874	608	472	-266	-402	-136
Total sum of (12) health risks	-	685	592	-	-	-93
Average of (8) health risks	1.49	1.41	1.30	-0.08	-0.19	-0.11
Average of (12) health risks	-	1.59	1.30	-	-	-0.29
Overall risk levels						
Low risk (0-1)	58.8 %	54.5 %	59.5 %	-4.3	+0.7	+5.0
Moderate risk (2-3)	32.5 %	34.6 %	30.0 %	+2.1	-2.5	-4.6
High risk (4 or more)	8.7 %	10.9 %	10.5 %	+2.2	+1.8	-0.4
Total	100.0 %	100.0 %	100.0 %			

TABLE 3. Health Risk Changes between 2010–2013, 2014–2017 and 2010–2017

	2010		2013			
COHORT 1 (N=359)	**n**	**%**	**n**	**%**	**difference**	***P***
Physical inactivity	62	17,3 %	55	15,4 %	-1.8 %	0.494
Low cardiovascular fitness	22	6,3 %	16	4,5 %	-1.8 %	0.327
High blood pressure	131	36,5 %	124	34,5 %	-1.9 %	0.752
High bmi	121	33,7 %	118	32,9 %	-0.8 %	0.749
Low vitality	4	1,1 %	8	2,2 %	+1.1 %	0.388
Musculoskeletal disorder	71	20,2 %	103	28,8 %	+8.6 %	0.001**
Illness days due to MSD	27	7,6 %	29	8,1 %	+0.5 %	1.000
Medication for cardiovascular disease	39	10,9 %	55	15,4 %	+4.5 %	0.001**
COHORT 2 (N=255)	**2014**		**2017**			
Physical inactivity	37	14,6 %	36	14,3 %	-0.3 %	1.000
Low cardiovascular fitness	12	4,7 %	13	5,1 %	+0.4 %	1.000
High blood pressure	84	32,9 %	77	30,3 %	-2.6 %	0.401
High bmi	84	32,9 %	90	35,3 %	+2.4 %	0.327
Low vitality	3	1,2 %	5	2,0 %	+0.8 %	0.453
Musculoskeletal disorder	62	24,3 %	52	21,1 %	-3.3 %	0.233
Illness days due to MSD	20	7,9 %	17	6,8 %	-1.1 %	0.690
Medication for cardiovascular disease	23	9,1 %	32	12,7 %	+3.7 %	0.031*
Chronic pain						
Chronic stress	5	2,0 %	10	4,0 %	+2.0 %	0.125
Smoking	10	4,0 %	15	6,1 %	+2.1 %	0.359
Alcohol	23	9,1 %	19	7,6 %	-1.4 %	0.424

	3	1,2 %	2	0,8 %	-0.4 %	1.000
COHORT 3 (N=253)	**2010**		**2017**			
Physical inactivity	42	16,6 %	36	14,4 %	-2.2 %	0.617
Low cardiovascular fitness	19	7,7 %	12	4,8 %	-2.9 %	0.481
High blood pressure	92	36,4 %	77	30,8 %	-5.6 %	0.237
High bmi	81	32,0 %	93	36,9 %	+4.9 %	0.023*
Low vitality	1	0,4 %	4	1,6 %	+1.2 %	1.000
Musculoskeletal disorder	42	17,0 %	40	16,1 %	-0.9 %	0.268
Illness days due to MSD	18	7,3 %	19	7,6 %	+0,3 %	0.850
Medication for cardiovascular disease	21	8,3 %	52	16,7 %	+8.4 %	0.000**

P values are based on the McNemar´s test for non-parametric paired nominal data.

Figures

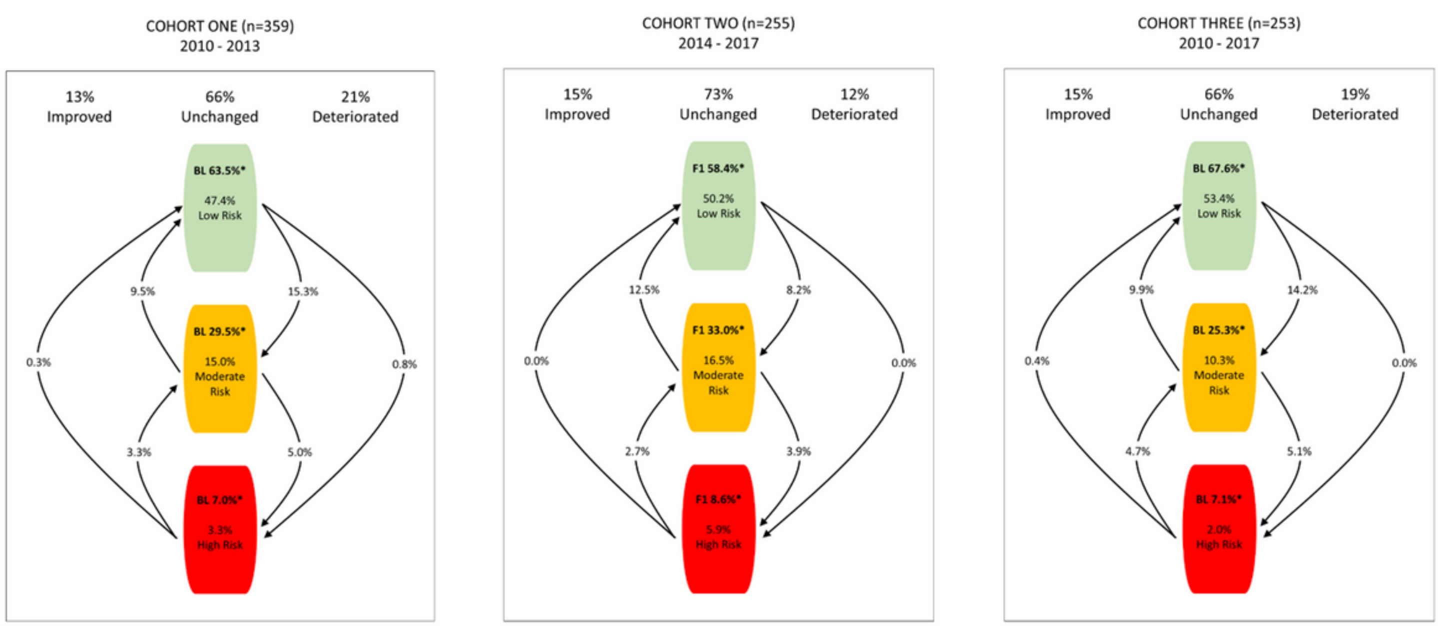

Figure 1

Overall Health Risk Level Transitions in Cohort One, Two and Three

Supplementary Files

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