FUNDAÇÃO GETÚLIO VARGAS
ESCOLA DE ADMINISTRAÇÃO DE EMPRESAS DE SÃO PAULO

CAIO PLOPPER

IMPACT OF WORKSITE HEALTH-PROMOTION PROGRAMS IN HOSPITAL ADMISSION COSTS AND MEDICAL LEAVES IN A SAMPLE OF BRAZILIAN COMPANIES

SÃO PAULO - SP

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Dissertação apresentada à Escola de Administração de Empresas de São Paulo, da Fundação Getulio Vargas, em cumprimento dos requisitos para obtenção do título de Mestre em Administração Empresas.

Campo do conhecimento: Economia de Empresas

Orientador: Prof. Dr. Antonio Carlos Manfredini da Cunha Oliveira

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a quem a doença hoje não permite entender esta nova etapa de minha vida.

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RESUMO

Programas de saúde e bem-estar têm sido adotados por empresas como forma de melhorar a saúde de empregados, e muitos estudos descrevem retornos econômicos positivos sobre os investimentos envolvidos. Entretanto, estudos mais recentes com metodologia melhor têm demonstrado retornos menores. O objetivo deste estudo foi investigar se características de programas de saúde e bem-estar agem como preditores de custos de internação hospitalar (em Reais correntes) e da proporção de funcionários que têm licença médica, entre Abril de 2014 e Maio de 2015, em uma amostra não-aleatória de empresas no Brasil, através de parceria com uma empresa gestora de 'big data' para saúde. Um questionário sobre características de programas de saúde no ambiente de trabalho foi respondida por seis grandes empresas brasileiras. Dados retirados destes seis questionários (presença e idade de programa de saúde, suas características – inclusão de atividades de screening, educação sobre saúde, ligação com outros programas da empresa, integração do programa à estrutura da empresa, e ambientes de trabalho voltado para a saúde – e a adoção de incentivos financeiros para aderência de funcionários ao programa), bem como dados individuais de idade, gênero e categoria de plano de saúde de cada empregado , foram usados para construir um banco de dados com mais de 76.000 indivíduos. Através de um modelo de regressão múltipla e seleção 'stepwise' de variáveis, a idade do empregado foi positivamente associada e a idade do programa de saúde e a categoria '*premium'* de plano de saúde do funcionário foram negativamente associadas aos custos de internação hospitalar (como esperado). Inesperadamente, a inclusão de programas de screening e iniciativas de educação de saúde nos programas de saúde e bem-estar nas empresas foram identificados como preditores positivos significativos para custos de admissão hospitalar. Para evitar a inclusão errônea de licenças-maternidade, apenas os dados de licença médica de pacientes do sexo masculino foram analisados (dados disponíveis apenas para duas entre as companhias incluídas, com um total de 18.957 pacientes do sexo masculino). Analisando estes dados através de um teste Z para comparação de proporções, a empresa com programa de saúde que inclui atividades voltadas a cessação de hábitos ruins (como tabagismo e etilismo), controle de diabetes e hipertensão, e que adota incentivos financeiros para a aderência de funcionários ao programa tem menor proporção de empregados com licençca médica no período analisado, quando comparada com a outra empresa que não tem estas características (também conforme esperado). Entretanto, a companhia com menor proporção de funcionários com licença médica também foi aquela que adota programa de *screening* entre as atividades de seu programa de saúde. Potenciais fontes de ameaça à validade interna e externa destes resultados são discutidas, bem como possíveis explicações para a associação entre programas de screening e educação médica a piores indicadores de saúde nesta amostra de companhias são discutidas. Novos estudos com melhor desenho, com amostras maiores e randômicas são necessários para validar estes resultados e possivelmente melhorar a validade interna e externa destes resultados.

Palavras-chaves

Programas de saúde; Empresas brasileiras; Licenças médicas; Saúde suplementar; custos com saúde

ABSTRACT

Worksite health promotion programs have long been adopted as means to improve employees' health, and many studies report positive economic returns on investments involved. However, studies with better methodology have started to show smaller returns. The aim of this study was to investigate whether characteristics of worksite health programs play a role as predictors of hospital admission spending (in current BRL) and the proportion of medical leaves from April, 2014 through May, 2015, in a non-random sample of companies in Brazil, through partnership with a health 'big data' company. A survey on the characteristics of workplace health program was responded by six large Brazilian companies. Data gathered from these six questionnaires (presence and age of health program, its characteristics – inclusion of screening, health education initiatives, link to other company's programs, program integration with company's structure and work environment oriented to health promotion - and the adoption of financial incentives for employee adherence), as well as individual data on employee age, gender, type of health plan offered, were used to build a database with over 76,000 individuals. Through multiple regression and stepwise selection of variables, employee's age was positively associated and the age of health promotion program and premium health plan were negatively associated with hospital admission costs (as expected). Unexpectedly, the inclusion of screening for disease and health education initiatives in the worksite health program were identified as significant positive predictor of hospital admission costs. To avoid misleading inclusion of maternity leaves, the data on medical leaves for male employees were analyzed (available only for two of the companies included, with a total of 18,957 male employees). Analyzing these data through a Z-test for comparing proportions, the company that included in its health promotion program activities aimed at targeting bad health habits (such as smoking and alcohol abuse), diabetes and hypertension control and that adopted incentives for employee adherence had a lower proportion of employees with medical leaves, as compared to a company without those features (also, highly expected results). However, the company with lower medical leave proportion was also the one that adopted screening activities. Sources of threats to internal and external validity of these results are discussed, as well as possible explanations regarding the association in this sample of screening activities and health education for employees with worse health-related outcomes for the companies are discussed. Further well-designed studies with random larger samples are needed to validate those results and possibly improve internal and external validity of these results.

Keywords:

Health programs; Brazilian companies; Medical leaves; Health insurance; Healthcare costs

1. Introduction

Work environments are especially important regarding public health, since the vast majority of the adult population spends a great deal of time at work, and these environments have significant and independent influence over habits and health choices. During the last decades, growing interest has emerged in the development of health and well-being promotion programs aimed at employees of companies, especially in the United States of America, with the recent *Affordable Care Act* (also known as *Obamacare*), aiming at potential higher productivity, lower absenteeism, and lower health care costs, and potentially leading to payment of lower health insurance premiums (BAICKER; CUTLER; SONG, 2010; LINNAN et al., 2008).

Occupational health and quality of life at the workplace encompass activities to preserve physical, mental and social integrity, not only acting on disease control, leading to health advances and higher life expectancy (ALBUQUERQUE, 1998). One of the most important and prevalent targets of worksite health promotion programs is driving health-related behavioral changes. That is based on the fact that medical costs of employees with no modifiable health risks (such as hypertension, obesity, smoking, inactivity, hyperlipidemia and hypertriglyceridemia) are 70% lower than those of employees with multiple modifiable health risks (GOETZEL et al., 1998).

Among the obstacles to successful implementation of health and well-being programs in organizations and corporations, lack of interest and low adherence among employees are especially important. Like the low adherence to treatment observed among patients with chronic diseases, this low adherence of employees to health programs in corporations and to change in habits and adoption of a healthier lifestyle is partly explained by behavioral economic theory. Human beings tend to excessively value present sacrifices or benefits. Likewise, the tendency humans usually have to keep the *status quo* unchanged and make choices framed as the default explain the low adherence to those programs (LOEWENSTEIN; BRENNAN; VOLPP, 2007).

The adoption of financial and non-financial incentives designed by health program managers can promote the alignment of interests between employees and the

company, stimulating employee adherence to those programs and improving their results, with potential benefits and gains to both companies and employees.

Despite having performed an extensive literature search, the author does not have knowledge of any organized academic study about the prevalence or the returns of health and well-being programs among Brazilian companies.

The aims of the current study are:

i. to investigate if comprehensive health and well-being programs have an influence over hospital admission costs in a sample of companies in Brazil;

ii. to investigate if comprehensive health and well-being programs have an influence over employee medical leave figures in a sample of companies in Brazil;

iii. to investigate if the offer of financial incentives for worker adherence to worksite health programs is associated with lower healthcare costs and medical leaves in a sample of companies in Brazil.

This text is organized in the following sections:

i. Theoretic basis: The most important and relevant literature on the development of worksite health programs in companies is reviewed, as well as some of the most relevant papers that describe cases with their implementation and results. This section also briefly reviews the literature on low adherence rates of employees to lifestyle and behavior change in light of economics, medicine and psychology.

ii. Data: The available data for this study is discussed, as well as the methods for database construction.

iii. Statistical Analysis: The rationale for selection of statistical analysis, variable selection and related methodology are described and discussed. The study hypotheses are stated.

iv. Results: The results of statistical analyses are presented and discussed.

v. Discussion: The results are discussed in light of the research objectives, main conclusions are drawn and possible contributions are forwarded and discussed.

2. Literature review

2.1. Health and well-being programs in companies

Health promotion strategies in the workplace can lead to clear benefits for workers and for companies alike, translating into higher productivity, lower absenteeism and lower healthcare related costs, and leading do lower premiums paid for health insurance. The adoption of such programs has been growing; in a survey in the USA, 77% of more than 500 companies studied had organized worksite health promotion programs in 2008, compared to only 19% of big companies in 2006 (BAICKER; CUTLER; SONG, 2010).

In a study published in 2008 (*2004 National Worksite Health Promotion Survey*), Linnan *et al.* analyzed the existence and design of worksite health promotion programs in American companies. With data from 730 interviews with a random sample of American private companies with more than 50 employees, divided in 35 extracts (designed from the number of employees and industry or economic sector), the prevalence and scope of health and well-being programs in the United States of America were studied. In that survey, 64.6% of the companies had at least one employee responsible for the implementation and follow-up of those health programs. However, only 6.9% of the companies included in the study had worksite health programs deemed comprehensive according to criteria established by the US Government's "*Healthy People 2010"* program (as compared to a 75% goal defined by the program). These criteria are:

- Adoption of health education initiatives;
- Social and physical environments supportive of health-related activities;
- Integration of the worksite health program to company policies;
- Linkage to related company programs, such as occupational health and benefits, health benefits and employee assistance;
- Health screening programs.

In this sample, companies with more than 750 employees had higher prevalence of comprehensive programs, with work environments that are more supportive of health promotion and more screening programs (LINNAN et al., 2008).

In an extensive study published in 2013 by the RAND Corporation and sponsored by the U.S Department of the Labor and Department of Health and Human Services, a survey was conducted with a probabilistic sample of 3,000 American companies with more than 50 employees (with the sample built by crossing industry type and number of employees), reaching a total of 19% response rate. In that survey, approximately half of US companies offered wellness promotion initiatives to their employees, and larger companies had the tendency to have more complex and extensive health and wellness programs. These programs usually offered screening activities (aimed at identifying health risks) and interventions (aimed at reducing risk behaviors and promoting healthy lifestyles). In that survey, 72 percent of those employers offering some wellness program were characterized as having a combination of screening activities and interventions (MATTKE et al., 2013).

In that survey, among employers who offered a lifestyle management program, the most common targets were nutrition (79%), smoking cessation (77%) and fitness activities (72%). Among those programs that included disease management strategies, the most common targets were diabetes mellitus (85%), asthma (60%) and coronary artery disease (59%) (MATTKE et al., 2013).

Even though the prevalence of worksite health programs considered comprehensive by the above mentioned criteria was low, many studies describe positive returns on investment provided by these programs. In order to be financially sustainable in the long term, a health promotion program must be able at least to pay for itself. The value of reduced medical costs, improved productivity, attraction of a well-fitted and talented workforce and other intangible benefits must exceed the cost of the program, including the potential offer of incentives (O'DONNELL, 2012).

The returns of quality of life programs are usually determined in financial terms, with formulas to calculate the financial return on investment (ROI). More broadly, another concept of health and quality of life program returns relates to the human capital. This model is based on the concept that human capital impacts the company's processes that make up a value chain, where financial and economic gains could be ultimately estimated. (OLIVEIRA, LIMONGI-FRANÇA, 2005).

In a review of 32 studies that reported returns of such programs (all of which had new well-defined interventions with properly defined experiment and control groups), only two studies failed to demonstrate lowering health care costs and only one failed to

demonstrate reduced absenteeism costs. In a meta-analysis of the results of those studies, the annual return on investment of these corporate health programs was 227% for health care costs and 173% for lower absenteeism, respectively (BAICKER; CUTLER; SONG, 2010).

Chapman published consecutive reviews about papers regarding the economic returns of worksite health promotion programs, with the last update published in 2012 including a total of 62 papers. In this last update, the author states that the literature regarding worksite health programs lacks methodological standardization among studies. Nonetheless, he still concluded that this systematic review showed strong reductions in absenteeism, healthcare costs and disability insurance. The author concludes that worksite health and wellbeing promotion programs remain one of the most effective strategies for reducing medical costs and absenteeism (CHAPMAN, 2012).

In a study published in 2014, however, Baxter *et al.* analyzed the relationship between methodological quality and the return on investment (ROI) reported by studies on workplace health programs. The authors included 51 studies, with a total of 261,901 participants and 122,242 controls. Their results showed that, overall, worksite health promotion programs had positive ROIs. However, studies with better design and higher methodological quality tend to have lower ROIs. The authors also report the tendency for overall methodological quality improvement of these studies over time (BAXTER et al., 2014).

Accordingly, Rongen *et al.* (2013) published a meta-analysis of the effectiveness of workplace health promotion programs that included 18 studies describing 21 interventions. They reported that the effectiveness of these programs was larger in young populations, in interventions with weekly contacts, and studies in which the controlled group received no health promotion. Studies with poor methodological quality reported higher effects of worksite health promotion programs (RONGEN et al., 2013).

Even though the vast majority of reports related to worksite health programs in the academic literature has been developed in the USA, a trend toward the amplification of their prevalence and complexity has been described around the globe. The most important strategic objectives for offering a worksite health program are improving productivity and presenteeism, reducing healthcare costs, reducing employer absence and improving workforce morale and engagement. The majority of US and international organizations with a worksite health promotion program do not report measuring financial outcomes of those programs (KIRSTEN, 2010).

In a survey published in 2006 of a representative sample of 565 Canadian companies with more than 100 employees (with a 79.8% response rate), the majority of companies had Employee Assistance Programs (EAPs, through which employees with alcohol and drug abuse or family problems receive short term counselling) and/or Health Promotion Programs (HPPs). The prevalence of health-related programs was heterogeneously distributed, with significant differences among Canadian provinces (MACDONALD et al., 2006).

Babu *et al.* published a review on worksite health and wellness programs in India in 2014. Despite the difficulties derived from the huge working population in India, and the higher number of employees belonging to an unorganized labor market than the ones in the organized one, the authors describe some published studies with proven reduction in risk factors such as high blood pressure through an integrated approach using education, screening and behavioral interventions. The authors identified various companies with health programs, and found that around two thirds of employees felt that their company actively promoted health and well-being among them (BABU et al., 2014).

The author has no knowledge of published academic studies on the prevalence, scope or returns of worksite health programs in Brazil.

2.2. Obstacles for worksite health programs and incentives for adherence

In the *2004 US National Worksite Health Promotion Survey*, the biggest barriers for successful implementation described by the interviewed program managers were the lack of interest by employees (63.5%), lack of staff and human resources (50.1%), shortage of funds (48.2%) and lack of participation of high risk employees (48%) (BAICKER; CUTLER; SONG, 2010).

In the 2013 survey published by the RAND Corporation, the authors describe that the uptake of worksite wellness programs by employees remains limited, with fewer than half of employees (46%) going through screening activities or completing their Health-Related Assessments (HRAs), frequently used to identify employees for health interventions. Among those identified for interventions, usually fewer than one fifth decided to participate

(21% for fitness interventions, 7% for smoking cessation, 10% for weight and obesity control, and 16% for disease management) (MATTKE et al., 2013).

The lack of interest of employees for taking part in worksite health programs is partly explained by the usual tendency of individuals for hyperbolic discounts, i.e. to attribute disproportionately higher value to close costs and benefits and lower value to distant ones, as well as the tendency to have more motivation for tangible benefits than for more intangible ones. This explains the low adherence to activities that cut present benefits (such as the pleasures of eating and leisure) in lieu of less tangible future benefits (such as lower cardiovascular disease incidence). Likewise, other behavioral economic phenomena such as the tendency of individuals to adopt default behaviors or maintain the *status quo* also explain the difficulty in changing unhealthy behaviors, even though that choice would have been the most rational one (LOEWENSTEIN; BRENNAN; VOLPP, 2007).

In this context, one way of increasing the adherence of employees to worksite health programs and to more adequate behaviors for health promotion is the adoption of financial or non-financial incentives, aligning attitudes and preferences of employees and corporations (HALL, 2005). Ideally, these incentives should be as simple as possible, cost-effective, and achieve the highest number of targeted people. Additionally, they should have the capacity of maintaining longstanding effects even after extrinsic incentive removal, due to the individual's intrinsic motivation (HALL, 2008).

Even though incentives are a very effective way of inducing desired behaviors in recipient individuals, in some instances offering incentives can have contradictory and paradoxical effects (KAMENICA, 2012). Some situations in which that can happen are:

a) Extrinsic and intrinsic incentives: Adoption of extrinsic incentives (for instance, financial ones) to motivate intrinsically interesting behaviors for the individual can have a negative long-term effect after incentive removal. The main interpretation of this phenomenon is the so called *crowding-out* effect, through which the existence of external financial incentive saturates the individual's intrinsic motivation. Thus, offering temporary incentives for the adoption of desired behaviors could be bad. This could explain the high levels of falling back to undesired behaviors after incentive removal (EISENBERGER; PIERCE; CAMERON, 1999; PROMBERGER; MARTEAU, 2013).

Analogously, there are studies that demonstrate the possible decrease in the adoption of pro-social behaviors (such as the willingness to donate blood) when extrinsic incentives are adopted or offered (KAMENICA, 2012).

b) Paying too much: Another effect of financial incentive introduction is described as *choking*. In this phenomenon, the introduction of very high value incentives for the achievement of a goal can lead individuals who receive them to very high stress levels, and to lower performance in key moments due to nervousness (even though more effort can be put in the task by the individual receiving the incentive). This effect is demonstrated, for example, in decisive moments in professional sport situations (ARIELY et al., 2009; KAMENICA, 2012).

c) Paying too little (or applying small penalties): The introduction of incentives or penalties of very low value can have an inferior effect, as compared to no incentive at all. This is demonstrated in various experiments; one classic study shows that the introduction of a small financial penalty for the parents who picked their children late in day care centers lead to paradoxically higher delays (GNEEZY; MEIER; REY-BIEL, 2011; GNEEZY; RUSTICHINI, 2000).

However, regarding incentives for the adoption of healthier behaviors, these paradoxical effects are not often observed. The main evidence related to *motivation crowding out* due to extrinsic incentives in the economic literature usually involve personal conflicts that are seldom evident in health-related situations. This effect usually relates to the recipient of financial incentives feeling that his behavior is being bought in a financial market. On the other hand, the perspective that employees may have that kind of interpretation regarding adherence to financial incentives for behavior change provided by employers more often than in research scenarios has to be taken into consideration by managers designing their incentives. (PROMBERGER; MARTEAU, 2013).

2.3. Financial incentives for the adoption of healthy habits and behaviors

Even though there may be negative effects of financial incentives on human behavior, the literature on financial incentives for the adoption of healthy habits and behaviors has demonstrated a growing number of clinical studies regarding their efficacy. Especially, some recent studies aim at investigating the long-term efficacy of financial incentives over the adoption and maintenance of healthy habits. (ADAMS et al., 2012).

Sutherland *et al.* (2008) published a comprehensive review of the literature regarding the impact of financial incentives on personal health behavior. In this review, the authors concluded that even small financial incentives have been demonstrated to be effective, at least in the short-term, to drive health behavioral changes (SUTHERLAND; CHRISTIANSON; LEATHERMAN, 2008). The paper outlines the following characteristics as decisive for the efficacy of financial incentives for health behaviors:

a) Size of incentives: usually, the larger the incentive, the higher the response rate;
b) Framing of incentives: the effectiveness of incentives is usually higher when those are framed as a penalty for undesirable behavior than a bonus for achieving targets;
c) Communication: The efficacy of incentives is also dependent on the way they are communicated to target populations;
d) Health literacy: People with low health literacy may not be able to adequately understand the benefits of changes in their health behaviors, and therefore require higher incentives in order to achieve the same goals;
e) Income: Income can potentially influence the response of individuals to financial incentives, either shaping the influence of the incentive on the overall increase in income, or by shaping the individual's willingness to incur the costs to uptake the desired behavior (such as transportation cost or the opportunity cost of the time dedicated to desired activity);
f) Self-efficacy: Especially for changes that are more complex or require sustained effort, differences in expected self-efficacy can explain differences in adherence among individuals. Therefore, higher incentives can be necessary to achieve behavior change in individuals with lower perceived self-efficacy.

In a systematic review that included 14 studies on the efficacy of worksite-based incentives and competitions for smoking reduction, Leeks *et al.* (2010) concluded that the evidence was insufficient to determine the efficacy of incentives and competitions alone, but that worksite-based incentives and competitions, when applied in conjunction with additional interventions are effective in increasing the number of employees that quit tobacco smoking (LEEKS et al., 2010).

A meta-analysis of 13 studies comparing the success rates for less than six months in smoking cessation programs with or without financial incentives showed a conjoined odds-ratio (OR) of 2.48 (95% confidence-interval 1.77 – 3.46) in favor of the adoption of financial incentives. In a subgroup analysis of eight comparative studies with longer than six months duration, the odds-ratio in favor of smoking cessation in the group with financial incentives was 1.50 (95% CI: 1.05 – 2.14). Based on these results, the authors concluded that financial incentives for smoking cessation had significantly positive results both in the short and long terms (GILES et al., 2014).

In the same paper, a meta-analysis on the efficacy of financial incentives over the adherence of people to vaccination programs and over the adherence to routine screening exams, the odds-ratio in favor of incentives was 1.92 (95% CI: 1.46 – 2.53). Subgroup analyses in that group of pooled studies revealed higher efficacy of financial incentives when associated to other motivational components (GILES et al., 2014). In a number of clinical situations, such as vaccination programs, population screening exams, treatment of chronic diseases such as diabetes and hypertension, lack of patient adherence is one of the main obstacles to program success and follow-up. These results suggest the possible positive interference of the adoption of financial incentives to gain better patient participation and adherence.

One controlled study on financial incentives for the engagement in physical activities (i.e. a study that included a control group that did not receive the incentives) revealed that individuals who received financial incentives had an increment in daily physical activity 16 minutes larger than those not receiving them, and that was statistically significant (FINKELSTEIN et al., 2008).

Purnell *et al.* (2014) conducted a meta-analysis of 12 studies concerning the use of financial incentives for healthy dietary behavior change. In this systematic review, 11 out of 12 studies revealed that financial incentives were found to have a positive effect on short-term dietary behaviors, with larger incentives associated with better outcomes. However, long-term maintenance continues to be a major concern (PURNELL et al., 2014).

In a meta-analysis of controlled studies about financial incentives for the adoption of healthy behaviors (when all included behaviors were jointly analyzed), the odds-ratio in favor of incentives was 1.62 (95% CI: 1.38 – 1.91). Thus, the adoption of financial incentives significantly increased adherence to healthy behaviors (GILES et al., 2014).

These results suggest the efficacy of both short and long term financial incentives for the adoption of various healthy behaviors (even though studies did not use a consistent and consensual definition of short and long-term effects), as well as for promoting better patient adherence to the treatment of chronic diseases.

Mattke et al (2013), in the above-mentioned RAND Employer Survey conducted with US companies, reported that 69% of the employers surveyed used financial incentives to encourage program uptake, and 10% designed incentives tied to health-related standards and targets. Around half the employees (49%) with worksite wellness programs offered incentives directly to all employees, whereas 31% administered incentives through their group health plans. Incentives are most often framed as rewards rather than penalties, and most common targets are screening activities such as HRA completion, followed by clinical screening and lifestyle management (MATTKE et al., 2013).

No systematic analysis on the adoption of financial incentives as part of Brazilian worksite health and well-being promotion programs exist. Their adoption and the potential association of financial incentives to worksite health program results represent an interesting gap in existing relevant business literature. One of the aspects included in this research is the possible role of financial incentives adopted by Brazilian companies to drive employee's healthy lifestyle changes and adherence to worksite health programs as a predictor of hospital admission costs or employee's medical leaves.

2.4. Considerations on disease screening and worksite health programs

Screening tests are used to diagnose asymptomatic individuals for undetected diseases or conditions. They have been used in many contexts for identifying conditions such as hypertension, diabetes, prostate cancer, colorectal carcinoma, breast cancer, etc. (HERMAN, 2006)

The concept of screening for disease is more than 150 years old, powered by the idea of a periodic physical examination for the general asymptomatic population (REISER, 1978) It gained popularity after World War II, and in the 1960s some groups began to question the validity and wisdom of widespread screening, leading to the publication in 1968 by the World Health Organization of the seminal monograph by Wilson and Jugner *The Principles and Practice of Screening for Disease* (WILSON; JUNGNER, 1968). In this monograph, the

authors stated that “the central idea of early disease detection and treatment is essentially simple. However, the path to its successful achievement (on the one hand, bringing to treatment those with previously undetected disease, and, on the other, avoiding harm to those persons not in need of treatment) is far from simple, though it may sometimes appear deceptively easy” (WILSON; JUNGNER, 1968).

In that classic work, Wilson and Jugner outlined principles and criteria to guide the appropriate selection of screening tools for the diagnosis of asymptomatic patients to be applied to populations. These principles have been very influential ever since (HARRIS et al., 2011; WILSON; JUNGNER, 1968). The following ten principles (with comments by the authors) were described by Wilson and Jugner, and are still fundamental in the decision to include activities in screening programs:

i. “The condition sought should be an important health problem”: this should not take into consideration only prevalence; conditions with serious consequences for the individual or the community may also justify the adoption of screening.

ii. “There should be an accepted treatment for patients with recognized disease”: This is perhaps the most important criterion; unless there is a specific treatment available, actual harm can be done by screening. Two questions should be asked: 1) Does treatment of the presymptomatic condition affect its course prognosis? 2) Does treatment of the symptomatic condition at an earlier stage affect its prognosis? Especially for question 1, if the answer is not a clear “yes”, there is no point or benefit in screening.

iii. “Facilities for diagnosis and treatment should be available”: One must have enough facilities available for the diagnosis and treatment of patients found positive for the condition; otherwise, screening activities can provide more harm than benefits.

iv. “There should be a recognizable latent or early symptomatic stage”: There must be a reasonable asymptomatic period in the course of the condition, to justify screening in order to diagnose patients in that period.

v. “There should be a suitable test or examination”: Screening test must be easy and quick, even though less sensitive and specific. In screening tests, higher false-positive test rates are more tolerated, while false-negative test are highly undesirable.

vi. “Tests should be acceptable for the population”: Acceptability is related to the potential risks involved and to the extent and results of prior health education initiatives.

vii. “The natural history of the condition, including development from latent to declared disease, should be adequately understood”: It is necessary to know what changes can be regarded as pathologic and if diagnosed changes are progressive.

viii. “There should be an agreed policy on whom to treat as patients”: There may be a ‘borderline’ situation in which patients are found by screening not to be totally ‘normal’ nor ‘clearly abnormal’. It is important to have a clear policy on either to treat or follow-up on these patients.

ix. “The cost of case finding (including diagnosis) should be economically balanced in relation to possible expenditure on medical care as a whole”: There are usually two general aims of screening: to improve health and to reduce costs.

x. “Case finding should be a continuing process and not a ‘once and for all’ process”: The benefits of ‘single-occasion’ screening is limited.

These ten principles have been recognized as fundamental for the decision to adopt screening activities, especially by public health services and agencies; however, these principles hold true for every screening scenario, and should be taken into consideration when delineating worksite health promotion-related screening initiatives. That is especially true for the ninth principle, with the need for the screening tool to avoid healthcare costs, and not increase them.

Almost 40 years after the classic work by Wilson and Jugner, Andermann *et al* revisited the literature regarding emerging new criteria for disease screening, in an era of possible genetic preclinical diagnosis (ANDERMANN et al., 2008).These new emerging criteria were:

i. The screening program should respond to a recognized need;

ii. The objectives of screening should be defined at the outset;

iii. There should be a defined target population;

iv. There should be scientific evidence of screening program effectiveness;

v. The program should integrate education, testing, clinical services and program management;

vi. There should be quality assurance, with mechanisms to minimize potential risks of screening;

vii. The program should ensure informed choice, confidentiality, and respect for autonomy;

viii. The program should promote equity and access to screening for the entire target population;

ix. Program evaluation should be planned from the outset;

x. The overall benefits of the screening should outweigh the harm.

According to the authors, many of these criteria reflect the Western society's trends, that include a shift from paternalism to informed choice and autonomy, managed healthcare with focus on cost-effectiveness, quality assurance and accountability for decisions made (ANDERMANN et al., 2008). Here too, even though these principles apply to most screening programs undertaken by public health and government agencies, they should hold true for the efficient implementation as part of worksite health promotion programs.

In a further review about screening programs, Harris *et al* (2011) outlined that important considerations would be made about the magnitude of potential benefits (especially considering the probability of adverse outcomes without screening, the degree to which screening identifies all individuals with the condition and the incremental health benefits of earlier *versus* later treatment) and potential harms (especially related to the frequency and consequences of a false-positive test, frequency and experience of people with overdiagnosis, the frequency and severity of harms of workup and treatment) of screening activities (HARRIS et al., 2011).

When planning and implementing worksite health screening programs, the principles of screening adoption, as outlined by Wilson and Jugner, should also be taken carefully into consideration(HALPERIN et al., 1986).

2.5. Considerations on workplace health education

As defined by the World Health Organization (WHO), “health literacy represents the cognitive and social skills which determines the motivation and ability of individuals to gain access to, understand and use information in ways which promote and maintain good health.”

“Health literacy means more than being able to read pamphlets and successfully make appointments. By improving people’s access to health information and their capacity to use it effectively, health literacy is critical to empowerment” (NUTBEAM, 2000).

Health education initiatives are efforts to improve people’s health literacy, their knowledge and capacity to act, improving their lifestyle, the way they use the health services, and raise awareness of the social, environmental and economic determinants of health, as well as be directed towards the promotion of individual and collective actions that promote changes in these determinants (NUTBEAM, 2000).

In this context, health education initiatives should be directed toward comprehensive health literacy gains, not only improving functional health literacy, but also developing critical health literacy and collective empowerment. Health education programs in the workplace should ideally not only transmit health information (although this remains an important step).

In a quasi-experimental study on workplace health education, sponsored by an important Health Management Organization (HMO) from California, US, involving a presentation and self-help books for more than 5,000 workers, Lorig *et al.* described a significant reduction in outpatient visits and their associated costs, and concluded that workplace health education initiatives could have positive returns with low cost self-care interventions (LORIG et al., 1985).

2.6. Considerations on work environments and health promotion

One other aspect included in the comprehensive criteria for worksite health promotion programs is the presence of a social and physical environment supportive of health-related activities.

A small number of studies that specifically address environmental changes in the workplace and their results on health-related issues have been reported. Pegus *et al.* described the development and construction of a walking track on company ground to stimulate exercise activities at a factory site, as part of a larger program. This study did not show an increase in exercise behavior or the ability to exercise among workers (PEGUS et al., 2002).

In a quasi-experimental study of South Carolina, US, state workers and their work environment, Kronenfeld *et al.* compared some agencies with worksite environment interventions to other control ones. One of the targeted actions was to stimulate the use of stairs among employees. A significant increase in self-reported exercise was described both in the intervention and the control group, which puts the results of work environment change in doubt (KRONENFELD et al., 1987).

Emmons *et al.* reported on worksite environment changes aimed at improved physical activity as part of a larger initiative in manufacturing worksites (The 'Working Healthy Program'). In this study, a significant increase in employees' exercise behavior was reported, as compared to the control condition (EMMONS et al., 1999).

Taking these results collectively into consideration, there is inconclusive evidence that worksite environment interventions *per-se* are a key determinant of health-related results in worksite health-promotion strategies.

2.7. Predictors of hospital admission costs

In a review of 42 published papers on predictors of medical utilization and hospital admission costs, Epstein *et al.* (1985) described several variables that were identified as positive predictors (EPSTEIN; CUMELLA, 1988). These variables were divided by the authors in six main groups:

i. Perceived health status: This is a variable commonly used in research papers, derived from self-reported health status information of individuals. This is commonly derived from questions such as "Compared to other people your age, do you see your health status as excellent, good, fair, or poor?", or a combination of questions. Data on perceived health status of individuals generally correlate

with total visits to physicians, as well as total hospital admissions and costs (EPSTEIN; CUMELLA, 1988).

ii. Functional health status: This category of variables commonly try to measure whether the individual is disabled or limited in usual activities, such as climbing stairs, walking half a mile, or performing activities of daily living. Generally, functional health status variables correlate negatively with total hospital admission costs (BRANCH et al., 1981; EPSTEIN; CUMELLA, 1988; EVASHWICK et al., 1984).

iii. Prior utilization: Several studies report that prior utilization of medical services is a consistent predictor of future utilization, since it is considered to be a good measure of overall health status and other factors that may contribute to health services utilization (EPSTEIN; CUMELLA, 1988).

iv. Clinical descriptors: Routine clinical and diagnostic information on individuals are powerful predictors of hospital costs. These include direct measures of health problems (such as the presence of chronic health problems like hypertension, diabetes or chronic pulmonary obstructive disease) (EPSTEIN; CUMELLA, 1988; J.W. et al., 1983).

v. Sociodemographic characteristics: A number of sociodemographic characteristics have been extensively studied and demonstrated to be predictors of higher hospital healthcare spending and admission costs. The most important and widely studied are basic sociodemographic characteristics (such as gender, age, urban residence, race), economic standing (such as income, employment status, white collar), and family support and structure (such as family size, marital status). Some of these have long been recognized as positive predictors of higher hospital admission costs, such as age and male gender (BOULT et al., 1993; EPSTEIN; CUMELLA, 1988; RAMIARINA; ALMEIDA; PEREIRA, 2007).

vi. Additional variables: Some additional variables have been less extensively studied, as predictors of hospital utilization and costs. These include mental status, nutrition, knowledge of community services and transportation barriers). Depression, for example, was related to higher hospital utilization and costs among elderly patients (WAN; ODELL, 2008).

In the present study, the sociodemographic characteristics gender and age were included as possible predictors of hospital admission costs in the studied population.

3. Data

This quantitative research was based on the construction of a database through the collaboration with *GESTO Saúde e Teconologia*, a São Paulo-based health information company (hereinafter called 'data provider'). It pioneered, in Brazil, the development of solutions to help Brazilian big companies and healthcare managers make decisions. It specializes on employee health information technology, gathering "big data" to help on the management of health insurance and worksite health-related issues. The company started in 2003, and is now owned by its founders and a major Brazilian private equity fund. In its data base history, it has collected data on more than 1.5 million subjects.

The data provider selected seven companies among its clients, for which data deemed reliable by its owners on healthcare spending were available for analysis (taking into account its own criteria based on its core competence). Thus, this study's database was derived from a non-random sample of companies, selected by a health information firm among its clients, based on the quality of data gathered from their workforce and the respective predicted response to the research survey. These seven companies were invited to participate in this joint research, and a survey regarding the companies' implementation of worksite health-related programs, their design and the adoption of financial incentives for employee adherence was sent to senior Human Resources managers starting in August, 2015. Available data on health insurance and costs of hospital admissions of active employees (ages ranging from 18 to 60 years) from those large Brazilian companies were retrospectively gathered, spanning twelve months (from May, 2014 through April, 2015), as well as data on medical leaves, when available. Retired employees or family members of workers were excluded.

This short time span (twelve months) was selected by the author and by the data provider, because this interval had the most reliable and comparable data among companies, and avoided missing data regarding earlier periods for which some of these companies did not provide data.

Some data on company size in Brazil, revenue and industry are described in Table 1:

Table 1: Data on surveyed companies

Company	**Industry**	**Location of Headquarters**	**Revenue in Brazil, 2014 (BRL Million)**	**Number of employees (Apr/2015)**	**Listed/ non-listed company**
I	Pulp & Paper	SP, Brazil	914	12,136	Listed
II†	Technology	California, USA	484	13,716	Listed
III†	Healthcare	SP, Brazil	74	4,710	Non- Listed
IV‡	Energy	Portugal	370	13,189	Listed
V	Consumer Discretionary	Michigan, USA	866	33,815	Listed
VI	Chemical	Switzerland	162	2,007	Listed
VII	Services	SC, Brazil	N/A	10,072	Non- Listed

N/A: not available; †: Data on medical leaves available; ‡: Did not respond questionnaire

The questionnaire to capture information on the existence, scope and comprehensiveness of worksite health promotion programs, sent to senior HR managers of participating companies, is described in Appendix 1.

3.1. Data base construcion

3.1.1. Dependent variables

In order to study health insurance-related costs, the dependent variables included in the data base were:

- Total yearly cost of hospital admissions per employee (in current BRL): This includes every expense paid through corporate health insurance or health plan, related to the admission of employees to a hospital or day-hospital facility. The costs of hospital stay, medicines, use of equipment and consumption materials, exams and diagnostic tools, as well as care provided by medical doctors, nurses and other healthcare professionals are included (either paid directly to the hospital institution or to the healthcare professional). This does not include treatments received by employees as outpatients, outside hospital facilities (such as home care), outpatient office visits, medicines or other out-of-hospital expenses.

- Number of medical leaves per employee (confirmed by doctor's report): The absolute number of medical leaves undertaken by each employee is thoroughly recorded and kept in a centralized database, aiding companies to cope with government regulations regarding the gathering and reporting of medical leave statistics, as well as providing consolidated data and analyses for company managers.

Both the cost of hospital admissions and the number of medical leaves are data gathered by the data provider directly from healthcare providers (such as health insurance and HMO companies) or the client companies Human Resources departments, with no data ambiguity.

3.1.2. Control variables

In addition to the existence and characteristics of worksite-related programs and the adoption of incentives for adherence, the following information was gathered for every employee:

- Date of birth
- Gender
- Habits (smoking, alcohol abuse, drug abuse) and presence of chronic disease (hypertension and diabetes)[1]
- Type of supplemental health plan policy[2]
- Health insurance coverage network classification[3]

3.1.3. Survey method

The survey was conducted through a questionnaire sent to senior Human Resources managers of the chosen companies, identified as people in charge of health-related issues, especially the administration of worksite health promotion programs. This questionnaire (described and discussed in Appendix 1) has the objective of describing the existence and age of the company's worksite health promotion program, its scope (i.e. the list of activities taken and the number of health-related conditions targeted by it), its structure, its use as a tool for the company's top management decision-making process and to which degree that program can be considered comprehensive, according to the *US Healthy People 2010* program ((U.S.); NATIONAL CENTER FOR HEALTH STATISTICS,

1. Even though these habits are usually under-reported, the author decided to include this as a control variable, because of its potential effect on health costs (CALLUM; BOYLE; SANDFORD, 2011; HERMAN; WALSH, 2011; NEUBAUER et al., 2006) and absenteeism (ARCAVI; BENOWITZ, 2004; PAPERWALLA et al., 2004; WWW.ASH.ORG.UK, 2013).

2. Type of supplemental health benefit are defined as health insurance (also called Preferred Provider Orgaization - PPO, where patients can seek out-of-network care and be reimbursed for payments made), Exclusive Provider Organization (EPO) plan or cooperative networks (in Brazil, usually the Unimed system).

3. The author classified health plans as 'premium' or 'basic', based on network-covered hospitals and laboratories and hospital accommodation class (single room or multiple-patient room), detailed in Appendix 2.

2012). This survey and its application was based on the classic work by Linnan *et al.*, on the US 2004 National Worksite Health Promotion Program (LINNAN et al., 2008).

The survey also tried to establish which companies designed programs with financial or non-financial incentives for the promotion of employees' participation and achieving program results.

In an effort to stimulate the responses rate, the online survey link was sent with an email from the data provider requesting responders to answer, as well as reminders in two weeks and phone calls in four weeks for initial non-responders.

3.1.4. Characteristics, limitations and quality of data

Six out of seven surveys were returned with complete answers (a response rate of 85.7%), with a total of **76,456** active employees (in April, 2015). The survey response was not sent only by company IV.

The construction of the database used to analyze healthcare outcomes in those companies was based on gathering data from the survey responses, as well as data provided by the provider, contained in their "big data" repositories. Data concerning the companies' introduction of an organized worksite health promotion program and its characteristics was solely obtained through the questionnaire, and neither the author nor members of the data provider were able to independently verify their authenticity or veracity. Even though the letter sent with the questionnaire stressed the need for accurate answers for the purpose of research quality, and the responders were all high-level managers from the companies studied, with assumed deep knowledge of their occupational health characteristics, data accuracy cannot be assumed. Moreover, self-selection bias may have been a potential factor of data inconsistency, as discussed in section 6.1.1.

Even though the data provider's database included individual data about employees' habits, such as smoking and alcohol abuse, these were deemed to have very low reliability; this is due to the fact that data on tobacco, alcohol and drug abuse were based on employee self-declaration, that usually leads to marked under-reporting (COX, 2008). Thus,

individual data on smoking, alcohol and other substance abuse, were excluded from this study's database.

On the other hand, individual data regarding expenses related to healthcare costs, such as hospital admissions, laboratory exams and office visits to doctors were provided by the data provider and are considered very accurate and reliable. This is due to the fact that its model works in great proximity to the companies' areas that manage Human Resources statistics, and gathering these data is their core activity. Moreover, data on medical leaves and absenteeism related to healthcare costs are usually also gathered by the data provider straight from Human Resources of client companies (or managed for them). Thus, these data are also considered quite reliable.

For this study, a database with entries on 76,456 employees, with no missing data regarding healthcare costs, was employed.

Reliable data on medical leaves in the data provider's database was only available for two of the seven companies included in the study (Companies II and III). When analyzing data on those leaves, the companies did not clearly discriminate between medical leaves (due to hospital admissions or diseases that precluded employees from going to work) and maternity leaves.

Thus, in order to avoid the erroneous inclusion of maternity leaves in the analysis, only data on the number of male employees who had a medical leave from May, 2014 through April, 2015 were gathered for those two companies.

4. Statistical modeling and analysis[4]

4.1. From databank structure to statistical model selection

The databank that resulted from the acquisition of data regarding worksite health promotion programs from company surveys as well as from the data provider's information about individual's costs of hospital admissions were available for 76,456 employees, as described in section 3.1.4.

According to the aim of this study, a statistical tool that could lead to the identification of independent variables significantly and independently associated to individual's hospital admission costs was to be found. The data set structure comprised information on the independent variable for every single individual in the databank, as well as a number of other pieces of information regarding individuals and the companies they worked for.

Analyzing the independent variables that were to be tested as potential predictors of hospital admission costs, these included both numerical continuous variables (such as employee's age or the company's worksite health program's age in years), and categorical 'dummy' variables (such as employee's gender, the individual type of health insurance and accommodation, presence or absence of single characteristics of the worksite health promotion program, and the adoption of financial incentives for employee adherence). One important characteristic of this data set is the possible existence of significant correlations (and colinearity) among independent variables; for example, the presence of some characteristics of a company's worksite health promotion program may be significantly associated to each other, or the presence of premium health insurance with individual accommodations could be associated with higher employee's age. When analyzing data to infer associations between worksite health program characteristics and health-related outcomes, a statistical model that takes this into consideration had to be chosen.

[4] The statistical analyses produced in this study were performed using the software Minitab 17.2.1.0 (Minitab Corporation, State College, PA, USA).

In this context, the development of a multiple regression model was chosen as the statistical tool of choice, in order to search for significant associations between the mentioned variables and the outcome (individual hospital admission costs).

Another different situation concerning data structure relates to information on medical leaves of employees, the second outcome to be tested. Thus, available data allowed the comparison of the number of employees who had at least one episode of medical leave (as a fraction of the total number of employees) in both companies. This data structure, and the aim to test the hypothesis that companies with different worksite health promotion program designs and/or financial incentive adoption for employee adherence have different proportions of medical leaves, lead to the choice of a two-tailed Z-test for the comparison of two proportions (since the null hypotheses is that proportions are not different and the alternative hypothesis states that the proportions differ).

4.2. On the choice of multiple regression

Multiple regression analysis is a highly general and therefore very flexible system for analyzing data; it can be used whenever a dependent quantitative variable is to be studied as a function of, or in relationship to, any set of multiple factors of interest (the independent variables) (COHEN et al., 1983).

The flexibility of multiple regression analysis relates to a number of its main characteristics:

i. The form of the relationship among variables is not constrained. This relationship may as simple as a straight line, for example, or it can be curvilinear, general or conditional, or combinations of these two possibilities.

ii. The nature of independent variables is not constrained either. The independent variables (or predictors) in a multiple regression model can be qualitative (such as a ‘dummy’ gender variable) or quantitative (such as age), main effects or interactions in the analysis of variance sense, they may be correlated or non-correlated to each other, there may be missing data. In short, virtually any

variable or set of variables that can be characterized as information whose bearing on the dependent variable is of interest may be used in a multiple regression model (COHEN et al., 2003).

This flexibility, and the ability to accommodate simultaneously in a statistical model a great variety of independent variables makes multiple regression a very useful and popular alternative for the analysis of data derived from social, behavioral and health sciences. Moreover, multiple regression analyses may be equally useful for observational studies, as well as experimental studies when one or more variables are controlled by the experimenter (NETER et al., 1996).

It is interesting to note that 'linear' in multiple linear regression models does not mean that the model is restricted to linear response surface shape. We say that a regression model is linear in the parameters when it can be written in the form:

$$Y = \propto + \beta_1 X_1 + \beta_2 X_2 + \beta_3 X_3 + \ldots + \beta_t X_t + \varepsilon$$

where the terms β_1, β_2, β_3,..., β_t are coefficients involving the predictor variables (NETER et al., 1996).

The main steps in multiple regression model construction for exploratory observational studies usually involve data collection and preparation, reduction of explanatory (or predictor) variables, model refinement and selection. Data collection and reduction of predictor variables are discussed briefly in the following sections.

4.2.1. Multiple regression feasibility for this exploratory study

Very often in health, behavioral, social, and business administration fields, it is not possible or feasible to conduct controlled experiments. As a consequence, many researchers in these fields conduct exploratory observational studies, aiming to search for explanatory variables that might be related to the response (dependent) variable. In these circumstances, the potential number of independent variables included in the data

collection strategy is usually very large (and desirably so, for researchers usually try to encompass most possible conceivable and measurable dependent variables).

After extensive lists of potential predictor variables are gathered and measured, some of these variables are usually screened out quickly. This usually happens when the explanatory variable is not fundamental to the problem, may be subject to large measurement errors, or may duplicate another independent explanatory variable in the list (NETER et al., 1996). Usually, variables that cannot be measured adequately may be substituted for proxy variables that are highly correlated with them. This was performed in this study, for example, by the exclusion of some variables related to employees' habits, such as tobacco and alcohol abuse. Even though these are potentially important data in a model for the analysis of factors associated to hospital admission costs and medical leaves, the quality and reliability of these were considered low (as discussed in section 3.1.4). This was also done in the present study when the information on which hospital was chosen by every employee who needed admissions was not used (even though it was available in the data provider's databases). Since admission costs for the same procedure may vary significantly among hospitals, ideally these costs should be controlled by the hospital institution chosen. However, this would lead to a very complex amount of information. Thus, the author opted for substitution of this variable by a much simpler proxy predictor variable, the class of health insurance provided by the employer (as discussed in Appendix 2).

The present study has these characteristics of an exploratory design, gathering data on a large number of possible independent variables. Moreover, these variables included both quantitative continuous variables (such as employee's age) and qualitative variables (such as employee's gender). As discussed in the previous section, a multiple regression model is considered a very adequate alternative for modeling and analyzing such a dataset.

4.2.2. Selection of terms in multiple regression

In many exploratory observational studies, the number of remaining potential explanatory variables after the initial screening is performed is still quite large. Moreover, some of these variables are sometimes highly inter-correlated.

Thus, for many reasons, investigators will usually want to reduce the number of explanatory variables for the development of the final model. First, large regression models are difficult to maintain and interpret; smaller regression models are usually easier to work with and interpret. Additionally, the presence of numerous inter-correlated explanatory variables may increase substantially the sampling variation of regression coefficients, reduce the model's descriptive abilities, and even reduce the model's predictive abilities. Actual worsening of the model's predictive ability can often occur when variables not related to the response variable are kept in the model (NETER et al., 1996).

The appropriate identification of a "good" set of explanatory variables is probably one of the most difficult and crucial problems in regression analysis, and needs to be done with great care. The elimination of key explanatory variables may often lead to reduced explanatory power of the model, biased estimates of regression coefficients, as well as predictions of new observations. Conversely, if too many variables are incorrectly kept in the model, these overfitted ones will frequently lead to larger variances of estimated parameters (NETER et al., 1996).

There are usually two different approaches to variables selection. When the pool of candidate explanatory variables is relatively small, one can consider all possible sets of potential variables that can be selected from the model, and then identifies subsets that are considered "good" according to researcher's criteria. Another one is to employ automatic search procedures that arrive at a one single set of explanatory variables as the "best" fit. This is a recommended approach for large sets of variables (NETER et al., 1996).

When applying the "all-possible" regression strategy for selection of a subset of variables, the researcher compares different subsets according to different criteria.

On the other hand, when analyzing more complex and extensive models, this "all-possible" strategy may not be feasible, and an automatic search procedure aimed at determining the "best" set of variables may be very useful. This strategy develops a sequence of regression models, at each step adding or removing an *X* variable. An essential difference between "all-possible" and automatic "best" is that the former leads to a number of different regression models considered "good" for final consideration, while the latter results in one single model deemed the "best" according to criteria chosen (NETER et al., 1996).

Automatic stepwise selection of terms selects a series of nested model specifications from simple to complex (forward selection) or from complex to simple (backward selection), then picking the "best" one. Thus, backward elimination usually starts with the full model, and then testing the model after the removal of one parameter. The idea is to select the best model at each step and then drop the term that was removed from the model.

In the model constructed in this study, forward stepwise selection of the best regression terms was chosen, because of the complexities of a large subset of predictors. The aim was to achieve an equation such as:

$$Y = \propto + \beta_1 X_1 + \beta_2 X_2 + \beta_3 X_3 + \ldots + \beta_t X_t + \varepsilon$$

where:

Y = COST: Hospital admission costs for each individual employee

X_n: Independent variables

β_n: Regression coefficients

ε: Error term

Table 2 below describes the independent variables included in this study, as well as their expected signs:

VARIABLE	DESCRIPTION	EXPECTED SIGN
	DEPENDENT VARIABLE	
COST	Hospital admission costs for each individual employee (in BRL) from May,2014 through Apr, 2015	-
	INDEPENDENT VARIABLES	
EAG	Employee's age (truncated)	A **positive** sign is expected, reflecting a higher incidence of chronic and malignant diseases in older adults.
GEN	Employee's gender (as a dummy variable) 1: Employee is a male	A **negative** sign is expected, due to obstetric hospital admissions for female employees.
PRE	Type of health plan (as a dummy variable) 1: Health plan is a premium insurance with individual accommodations	A **positive** sign is expected, since hospital admission in premium hospitals is more costly than in basic ones.
PAG	Worksite health program's age (in years)	A **negative** sign is expected, since mature programs are expected to have long-lasting results in health promotion and hospital admission cost reduction.
SCR	Inclusion of health screening activity in worksite health promotion program (as a dummy variable) 1: Program includes screening activities	A **negative** sign is expected, since activities included in worksite health programs are devoted to health promotion and are expected, therefore, to reduce hospital admissions.
EDU	Inclusion of health educational activities in worksite health promotion program (as a dummy variable) 1: Program includes health educational activities	A **negative** sign is expected, since activities included in worksite health programs are devoted to health promotion and are expected, therefore, to reduce hospital admissions.
ENV	Inclusion of work environment physically and socially oriented to health promotion and disease prevention activities in worksite health promotion program (as a dummy variable) 1: Program includes healthy work environment	A **negative** sign is expected, since activities included in worksite health programs are devoted to health promotion and are expected, therefore, to reduce hospital admissions.
INT	Integration of worksite health	A **negative** sign is expected,

	promotion program to company's structure (as a dummy variable) 1: Program is integrated to company's structure	since activities included in worksite health programs are devoted to health promotion and are expected, therefore, to reduce hospital admissions.
LIN	Link between worksite health promotion program and other programs the company has (as a dummy variable) 1: Program is linked to other company's programs	A **negative** sign is expected, since activities included in worksite health programs are devoted to health promotion and are expected, therefore, to reduce hospital admissions.
FIN	Adoption of financial incentives for employee participation in the worksite health promotion program (as a dummy variable) 1: Company adopts financial incentives for employee adherence	A **negative** sign is expected, since activities included in worksite health programs are devoted to health promotion and are expected, therefore, to reduce hospital admissions.

All the above variables were included as candidate terms for stepwise selection of terms to build the multiple regression model.

4.3. <u>On the choice of a Z-test and the comparison of proportions of medical leaves</u>

In order to test if there were significant differences between the proportion of medical leaves in the companies studied, the data provider's databases only had consistent data on medical leaves of employees available for two of the companies included (namely companies II and III), as discussed in section 3.1.4.

The proportion of male employees who had at least one episode of medical leave during the study period was compared among these two companies through a two-tailed Z-test; a p level inferior to 0.05 was considered statistically significant, to reject the second null hypothesis.

When evaluating differences between two proportions on the basis of independent samples, a Z test for the difference between two proportions may be used. The test statistic Z, that is used to determine the difference between the two populations, is based on the difference of the two sample proportions ($p_{s1} – p_{s2}$). Because the null second

hypothesis states that p_1 and p_2 are equal and the alternative hypothesis states that they are different, a two-tailed test was applied (BERENSON, *et al.*, 2004).

5. Study hypotheses

Based on the objectives described in section 1, the hypotheses formulated for test through the described statistical model in this sample are:

First hypothesis:

$H0_1$: In multiple regression analysis, the characteristics of employer worksite health programs are not significantly related to the costs of hospital admissions of employees.

$H1_1$: In multiple regression analysis, the characteristics of employer worksite health programs are related to the costs of hospital admissions of employees.

Second hypothesis:

$H0_2$: The characteristics of employer worksite health programs are not significantly related to each employee non-obstetric related medical leaves.

$H1_2$: The characteristics of employer worksite health programs are related to each employee non-obstetric related medical leaves.

6. **Results**

6.1. Survey responses

Six out of seven surveys were returned with complete answers, with a total of **76,456** active employees. Since this survey was sent to a highly selected and potentially biased small sample of companies, such a high response rate was expected to happen. The survey response was not sent only by company IV.

Among the responders, only one of the companies reported not having an organized worksite healthcare program. The other five companies reported having programs initiated from 2010 to 2014.

Table 3 depicts the activities included in those programs.

Table 3: Worksite health program characteristics among respondents

	Company I	Company II	Company III	Company V	Company VI	Company VII
Has an organized worksite health program	Yes	Yes	Yes	Yes	Yes	No
Year the program was initiated	2010	2010	2010	2012	2014	-
Blood pressure control	No	No	Yes	No	Yes	No
Alcohol abuse control	No	No	Yes	No	Yes	No
Diabetes control	No	No	Yes	No	Yes	No
Smoking control	No	No	Yes	Yes	Yes	No
Physical activity promotion	Yes	Yes	Yes	Yes	Yes	Yes
Healthy eating / Obesity control	Yes	Yes	Yes	Yes	Yes	Yes
Screening exams	Yes	Yes	No	Yes	Yes	No
Flexible working hours / home office	Yes	Yes	No	Yes	Yes	No
Prenatal assistance	Yes	Yes	Yes	Yes	Yes	No

Employee assistance	Yes	Yes	No	Yes	Yes	No
Stress control	No	Yes	Yes	No	Yes	No
Uses program data for managerial decisions	Yes	Yes	Yes	No	Yes	-
Adherence is part of employee KPIs	No	No	Yes	No	No	-
Uses financial incentives for adherence	Yes	No	Yes	No	No	-
Space for physical activities in-company	No	Yes	Yes	No	Yes	No
Showers for employees in-company	No	Yes	Yes	Yes	Yes	No
Partnership with external Gym	Yes	Yes	Yes	No	Yes	Yes
Area for smokers	No	Yes	No	No	Yes	Yes
Employees dedicated to program management	7 or more	4 to 6	7 or more	1 to 3	None	-
Health education for employees	Yes	Yes	Yes	Yes	Yes	No
Work environment physically and socially dedicated to health promotion	No	No	Yes	Yes	Yes	No
Program integration to organization structure	No	Yes	Yes	Yes	No	No
Program linked to other company programs	Yes	Yes	Yes	Yes	Yes	No
Worksite disease-screening initiatives	Yes	Yes	Yes	No	Yes	No

KPIs: Key performance indicators

Like individual data on every employee in the database, the company characteristics in the table above were included as potential candidates for variable selection as predictors of hospital admission costs, as well as medical leaves.

6.2. Analysis on predictors of hospital admission costs

The regression model was built using the stepwise method for variable inclusion, with all variables described in Table 2 as candidate terms.

The results of this stepwise selection of regression terms are depicted in Table 4 below:

Table 4: Results of Stepwise selection of terms for multiple regression:

DEPENDENT VARIABLE: COST = HOSPITAL ADMISSION COSTS										
INDEPENDENT VARIABLES										
	Step 1		Step 2		Step 3		Step 4		Step 5	
	Coeff.	P	Coeff.	p	Coeff.	p	Coeff.	p	Coeff.	P
Constant	199		455		640		707		602	
EAG	13.41	0.000	13.57	0.000	11.73	0.000	10.26	0.001	10.22	0.001
PAG			-78.2	0.000	-164.7	0.000	-172.9	0.000	-281.7	0.000
SCR					401.7	0.000	342.7	0.000	494	0.000
PRE							296.8	0.002	326.7	0.001
EDU									464	0.005
S		7989.13		7988.14		7987.04		7986.6		7986.24
R^2		3%		5%		8%		9%		11%
R^2 (adj)		3%		5%		8%		9%		10%
R^2 (pred)		2%		5%		6%		7%		4%

α to enter: 0.05; α to remove: 0.05

The group of variables chosen from this stepwise regression model is the one derived from step 5, with EAG, PAG, SCR, PRE and EDU as the independent variables identified as significant predictors of hospital admission costs. In this stepwise regression model, the one variable that has the largest contribution to the regression coefficient R^2 is individually added to the model at each step, and the program stopped admitting variables to the model when no other variable made a contribution that was statistically significant at the 0.05 level. Up to step 5, the variables included were statistically significant at the 0.05 level.

The model summary of the multiple regression is depicted in Table 5 below:

Table 5: Model summary for multiple regression

DEPENDENT VARIABLE: COST = HOSPITAL ADMISSION COSTS							
INDEPENDENT VARIABLES							
	DF	Coeff.	Standard Error (Coeff)	95% Confidence Interval	T-value	p-value	VIF
Constant	5	602	136	(336, 869)	4.43	0.000	
EAG	1	10.22	3.00	(4.34, 16.10)	3.40	0.001	1.04
PAG	1	-281.7	46.6	(-373.0, -190.5)	-6.05	0.000	7.18
SCR	1	494	103	(292, 696)	4.79	0.000	3.11
PRE	1	326.7	96.9	(136.7, 516.7)	3.37	0.001	1.26
EDU	1	464	166	(138, 790)	2.79	0.005	3.79
S	7986.24						
R^2	11%						
R^2 (adj)	10%						
R^2 (pred)	4%						

Thus, the regression equation derived from the model is:

$$\boldsymbol{Y = 602 + 10.22EAG + 326.7PRE - 281.7PAG + 464EDU + 494SCR + \varepsilon}$$

The EAG coefficient is significant at the 0.001 level, and equal to 10.22; this suggests a positive correlation between employee's age and his/her total cost of hospital admissions in the period studied. According to the model results, every additional year in employee's age is related to a predicted BRL 10.22 increase in total hospital admission costs. This is in line with expected signs, as described in Table 2 from section 3.2.4.

The PAG coefficient, on the other hand, is equal to – 281.7 and is significant at the 0.0001 level. This suggests an independent negative correlation between worksite health promotion program age and total hospital costs for each individual employee (with average reduction of BRL 281.7 for every year the program has been in place). Here again, this is in line with the expected negative sign described in Table 2, section 3.2.4.

The PRE coefficient is also positive and significant at the 0.001 level, equal to 326.7 (suggesting an average BRL 326.7 increase in total hospital admission costs for the inclusion of one employee into a premium health insurance plan with individual accommodations). This was also a widely expected result, as described in Table 2 in section 3.2.4.

However, both coefficients related to SCR and EDU variables were positive. The SCR coefficient was significant at the 0.0001 level, equal to 494, suggesting higher total hospital admission costs for employees of companies that include screening activities in their worksite health promotion programs. Accordingly, the EDU coefficient was also significant at the 0.005 level and equal to 464, also suggesting higher total hospital admission costs for each employee of companies that include health education activities in their worksite health promotion programs.

These two results, with positive coefficients for SCR and EDU are quite unexpected. Even though more comprehensive worksite health programs with health educational activities and worksite disease screening activities were expected to result in reduced healthcare costs for the companies that adopt them, these results suggest the opposite, with increased hospital admission costs related to those activities. This highly unexpected outcome merits a more detailed analysis, which will be conducted in the 'Discussion' section.

6.3. Analysis on medical leaves

As previously described in section 3.2.4, data reliably describing medical leaves of employees was only available for two of the companies included (companies II and III). When analyzing data on medical leaves of male employees of these companies from May, 2014 to April, 2015 (to avoid the inclusion of maternity leaves in the analysis), we had the features described in table 6 below:

Table 6: Data on medical leaves from May, 2014 through April, 2015

	Total number of employees	Employees on medical leave
Company II	13,965	132
Company III	4,992	23

Applying a Z-test for the comparison of two proportions, the Z-score is 3.2625, and the p value equals 0.00112, thus being significant at the 5% level. The proportion of male employees who had a medical leave during the study period in company II was significantly higher than the one in company III. This outcome will also be analyzed in the 'Discussion' section.

7. Limitations on Internal and External Validity

Internal validity can be defined as the condition that observed differences in the dependent variable are a direct result of the independent variable(s), not some other variable (GAY; MILLS; AIRASIAN, 2009). Thus, a research results' internal validity is threatened whenever plausible rival explanations for dependent variable behavior other than the independent variable are not fully eliminated. External validity, on the other hand, can be defined as the extent to which the study results can be generalized to and across other populations, settings, times and possibly other experimenters (BRACHT; GLASS, 1968).

Some of the most classic works on threats on internal and external validity of experimental and quasi-experimental quantitative research studies were published by Donald Campbell (CAMPBELL, 1957; HAAS; KRAFT, 1984). In his seminal works, Campbell delineated the main threats on internal validity of experiments, some of which are more pertinent to this study design and will be further discussed. Other authors, subsequently, have argued that concerns on internal and external validity should not only be evaluated for experimental design research, but also are pertinent for other non-experimental quantitative research studies, such as descriptive, observational, correlational and quasi-experimental ones. Discussing threats on internal and external validity of research has at least two advantages. First, providing information on the potential sources of invalidity allows the reader to place the researcher's findings in their proper context, avoiding the misleading impression that no external replications are needed. Second, identifying threats to internal and external validity helps to provide directions for future research. Most importantly, almost every research design on social sciences has a myriad of potential

threats to internal and external validity; discussing them points out to the readers potential future research opportunities where those threats can be minimized and replications should be of value (ONWUEGBUZIE, 2003).

In this study, a low regression coefficient (R^2 = 11%) denotes validity limitations of the results.

7.1. Threats to internal validity in the present study

Threats to internal validity (or, equivalently, to internal replication) represent the extent to which the results of this study would not re-occur if it was replicated using the exact same population, settings, context and time. If the independent variables truly were responsible for changes in the dependent variable, with no plausible rival hypotheses, then conducting an internal replication would yield exactly the same results. In other words, internal validity threats are potential confounding factors that could lead to rival hypotheses on the behavior of the dependent variables. Based on the seminal framework delineated by Campbell (CAMPBELL, 1957; HAAS; KRAFT, 1984; ONWUEGBUZIE, 2003), and further expanded by other authors, the main threats to internal validity regarding the present study data structure and analysis can be classified as detailed in what follows.

7.1.1 Differential selection of participants

Differential selection of participants (BERK, 1983; CUDDEBACK et al., 2004), also known as **selection bias**, refers to substantive differences between two or more of the comparison groups prior to the implementation of the intervention. This potential threat to internal validity, which clearly became realized at the data collection stages of this research, most often are present whenever already-formed (i.e. non-randomized or non-probabilistic) groups are compared (HERNÁN; HERNÁNDEZ-DÍAZ; ROBINS, 2004).

The main potential sources of selection bias in the present study are:

- Inappropriate selection of participants: In order to avoid (or minimize) selection bias, researchers should make every effort to assess the equivalency of groups by comparing them in as many variables as possible. These efforts are aimed at assuring that groups selected for analysis are adequately representative of the target population. The present study was based on the comparison of companies selected non-randomly by the data provider among its clients based on data availability, potential willingness to participate and with prior knowledge by selectors about the existence or absence of an organized worksite health program in the selected companies. Therefore, it is not straightforward to affirm that results obtained from the sample of companies studied hold true for the whole population of companies within its database, not to mention the entire Brazilian employed population.

- Volunteer bias / self-selection bias: The present research analyzes data on companies that volunteered to respond. In itself, this already poses a threat to internal validity, because one cannot at all assume that the decision to participate on a study is made at random, rendering the assumption that subjects (or groups) that volunteered or not volunteered to participate are comparable. In other words, whenever self-selection bias exists, the actually studied sample may not be certainly taken as representative of the target population, and the possible presence of potential confounding factors in subject self-selection must be taken into consideration.[5]

- Nonresponse bias / missing data bias: The fact that subjects included in a research study that decline participation or miss an observation thus generating missing data cannot be assumed to happen randomly. Regardless of the reasons why data are missing, analyses restricted to subjects with complete data can always be biased (HERNÁN; HERNÁNDEZ-DÍAZ; ROBINS, 2004).

[5] In the present study, one of the companies included declined participation and did not send any response to the questionnaire. This points to a potential source of selection bias.

Thus, the described potential sources of selection bias pose a potential threat to internal validity of conclusions. Results obtained from the analysis of the six-company sample certainly may hold true for the sample itself, but cannot be certainly be considered to reflect the reality among other non-included companies.

Some of the reasons for the potential lack of internal validity and selection bias in the sample are related to its non-probabilistic nature, leading to the cross-sectional study of a relatively small sample of companies. Potential replicating study designs could address this by developing a cross-sectional study of much larger probabilistic sample of companies, allowing for the inclusion of many more variables to be used as controls. For example, one potential relevant variable could be the industry where a company is inserted.

7.1.2. History

History threat to internal validity (CAMPBELL, 1957) refers to the occurrence of events that are unrelated to the interventions or variables tested, but that occur simultaneously during the study and can produce changes in the outcome measure. The longer the time span of a study, the more likely that this history effect can introduce confounding variables that can alter outcomes measured.

In addition to designing and implementing worksite health-related programs, companies and employees also develop a myriad of activities or are exposed to a great number of situations that could, individually or in conjunction, alter the outcomes measured, leading to internal validity questions. The history of worksite health programs in the sample analyzed in this study is not large (maximum 4 years) and the interval of data evaluation comprises only 12 months, this effect has to be considered as potential source of internal invalidity.

7.1.3. Instrumentation

The instrumentation threat to internal validity (CHENAIL, 2011) arises whenever measurement of an outcome lacks the appropriate level of consistency (i.e., has low reliability) or does not generate a valid observation result, as a result of inadequate content-, criterion- or construct-related validity. This is particularly true when data are collected through observations and the observation scoring is not consistent from one situation to another within an observer (i.e., there is low intra-observer consistency), or is not consistent among two or more data collectors or analysts (i.e., there is low inter-observer consistency).

This type of threat poses an important potential source of internal invalidity. Even though efforts have been made to use clear concepts in the questionnaire sessions, inter-observer criteria inconsistencies could possibly occur, leading to instrumentation threats on internal validity.

7.1.4. Mortality, or survival bias

The threat known as ‘mortality effect’, also known as ‘attrition’, (ZHOU et al., 2005) refers to the fact that participants that have been selected to participate in a research study do not participate in every phase of the investigation (i.e., drop out of the study). This is particularly important when subjects are lost to follow-up.

The loss of participants, *per se*, does not necessarily lead to internal invalidity. This bias occurs when participant attrition leads to differences between the groups that cannot be attributed to the studied intervention.

In this study, a possible source of attrition is the fact that, in companies with older worksite health programs, there are employees admitted more recently that do not reflect appropriately the effect of a longer history of the worksite health program. Also, it is possible that ‘healthy’ people leaving the companies across the time spam of the study may make employees with medical conditions over-represented or vice versa.

7.1.5. Researcher bias

This source of researcher bias (CHENAIL, 2011) may occur during the data collection phase when the researcher (or data collector) has a personal bias in favor of one technique over the other.

In this study, researcher and data collectors are healthcare professionals, and it is possible that their choice of subjects to be included and data collection could have been influenced by a natural desire to show benefits of the intervention or its comprehensiveness.

7.1.6. Treatment replication error

Treatment replication errors occur when researchers collect data that do not reflect the appropriate unit of analysis (DELGADO-RODRÍGUEZ; LLORCA, 2004; ONWUEGBUZIE, 2003). The most common form of replication error occurs when an intervention is administered once to each group of participants, but individual results are collected and computed. This kind of practice violates the assumption that each replication of the intervention for each and every participant is independent on the replication to all the participants exposed.

This source of potential threat to validity is also present when analyzing the design of this study, since data on individual medical leaves or hospital admission costs were collected, assuming that the potential exposure and availability of the worksite health program are equal among employees.

7.1.7. Multiple-treatment interference

This occurs when the same research subjects re-exposed to more than one intervention, making it difficult (and sometimes impossible) to isolate the effect of the studied design (BARLOW; HAYES, 1979; HAAS; KRAFT, 1984). When individuals receive

multiple interventions, carryover effects from an earlier intervention may make it difficult to assess a later one, thus providing rival explanations to the outcome. This effect may also be present in this research sample.

7.1.8. Reverse causation

Cause and effect can create biases because of reverse causation, whenever the effect is deemed responsible for the cause (CAMPBELL, 1957; RIVERA; CURRAIS, 1999). In some studies, sometimes the outcome can precede the intervention, and correlations found in the research results can be possibly misinterpreted by reversing causes and consequences. For example, it can occur when a blood parameter affected by the presence of cancer is measured after a patient has the disease. Inadequate interpretation of this correlation can lead a researcher to suppose the elevated blood marker can be part of the cause of disease.

In this study sample, hospital admission costs were shown to be significantly associated with the presence of some features of worksite health programs. Common thought would be that features of these worksite programs could be leading to higher spending. On the other hand, this statistical relation could reflect worksite health programs being adopted in response to high or increasing healthcare costs, or simply companies with better financial results may offer their employees more comprehensive worksite health-promotion programs and more 'generous' health plans, leading to higher costs.

7.2. Threats to external validity in the present study

Potential threats to external validity are usually classified into two broad categories: *population validity* and *ecological validity*.

Population validity refers to the potential adequate generalization of research findings in the included subjects to the whole target population. In order to affirm that research findings have external validity, researchers have to make two *jumps*: from the

sample to the experimentally accessible population and from the experimentally accessible population to the whole target population. (RAJU et al., 1997)

The first 'jump' is usually a matter of inferential statistics, if the researcher has formed adequately a probabilistic sample among her accessible population. However, if the included sample has not been formed by randomly selecting among the accessible population a probabilistic extract, the experimenter cannot generalize with probabilistic rigor her conclusions to larger groups of subjects (BRACHT; GLASS, 1968). The second 'jump', from the accessible population to the whole target population can generally be made with less confidence and rigor than the first one. The only basis for the inference related to the second 'jump' is a thorough knowledge of the characteristics of both populations and how these characteristics interact with the experimental treatment (BRACHT; GLASS, 1968).

The degree of confidence with which a researcher is able to generalize her findings and conclusions in social sciences is usually not known, because the investigator is never able to sample randomly from the true entire target population. As noted by Hinkelman and Kempthorne, even if we could draw a truly random sample from the whole target population, by the time the results are analyzed the target population has already changed and true absolute generalization is never possible (BRACHT; GLASS, 1968; HINKELMANN; KEMPTHORNE, 2007).

When interpreting results coming from small or non-random samples, the investigator must be very careful not to over-generalize her conclusions. Instead, investigators should compare their results to the available literature as comprehensively as possible, in order to put the results in a realistic context. In fact, researchers should refrain from assuming that any study without any external replication, regardless of methodological rigor and probabilistic sampling, could ever definitely answer a research question adequately. Researchers should focus on advocating external replications, allowing for a progression of research questions, which, if properly addressed in future studies, would provide increasingly accurate and generalizable results (ONWUEGBUZIE, 2003).

When analyzing the present study design, it stands out that a convenience, non-probabilistic sample generated from the accessible population of companies in Brazil that are clients of the data provider could not claim to have adequate external population validity.

However, the construction of a wide probabilistic database encompassing the diverse Brazilian companies was deemed not feasible for this study. In fact, such comprehensive probabilistic databases demanded a great amount of time and financial resources to be constructed in other settings, and even so, response rates were low and external validity threats still persisted. (LINNAN et al., 2008a; MATTKE et al., 2013)

Similar discussions on *ecological* external validity pertain to the generalizability of research findings obtained from a sample to target populations inserted in other environments. (GOLAFSHANI, 2003) In addition to the obvious possible interference of geographic and environmental factors over subjects' response to interventions, other effects can jeopardize ecological external validity assumptions. One very specific and widely known example is the classic *Hawthorne effect*, through which a subject's knowledge about being observed may alter his response to the intervention. In this scenario, the response found cannot be totally accounted for by the intervention effect (BRACHT; GLASS, 1968). In this research, this effect is not pertinent to data base collection, but could well play a role in modulating responders' answers to the questionnaire, since all responders were aware about the nature of this research.

As well as discussed for population external validity, this present study, based on a non-probabilistic sample of six big Brazilian companies cannot claim to have ecological external validity. Rather, the results and conclusions hold true for the sample of companies, and statistical inferences should be limited to that sample. In order to achieve higher levels of internal and external validity, further research should be designed and implemented in order to minimize the threats discussed above.

8. Discussion

One of the main benefits of the implementation of worksite health promotion programs in companies around the world (especially described for companies in the USA and Europe) is the reduction of hospital admission costs, thus leading to potential reductions in

health insurance premiums paid by companies. Moreover, in the US (where worksite health programs have been most extensively studied), the adoption of so-called comprehensive health programs for employees, linked to the organizational structure and including health education, screening initiatives and work environments dedicated to health promotion, has been promoted by American government policies with the *Affordable Care Act*.

In Brazil, academic studies on the impact of worksite health promotion programs on the costs of companies' health insurance or employee hospital admission costs lack. In this study, based on data of more than 76,000 active adult employees from six companies, the analysis of individual hospital admission costs per employee determined that employee's age and the type of supplemental health plan offered (namely premium insurance plans with individual apartment accommodations) were significant independent positive predictors of hospital admission costs. Those results are fairly predictable, since older patients have higher incidence of chronic and malignant diseases and thus tend to have higher hospital admission costs, and admission to premium hospitals with private apartment accommodations are obviously more expensive than basic ones with collective accommodations.

When the features of worksite- related health programs from included companies were analyzed, the program age was also an independent significant predictor of lower hospital admission costs (despite the low R^2 of 11%). That is also predictable and aligned with the literature, with the tendency of more mature and well-developed health programs to drive lower hospital admission costs.

In the sample of companies studied, other features of comprehensive programs according to *"Healthy People 2010"* criteria - ((U.S.); NATIONAL CENTER FOR HEALTH STATISTICS, 2012), the adoption of financial incentives for employee adherence to worksite health programs or the inclusion of this adherence to employee performance analysis were not independent factors associated with higher or lower hospital admission costs. Based on the literature on financial incentives for healthy lifestyle changes and the literature on the results of worksite health-promotion programs, a negative correlation between the adoption of financial incentives for employee adherence to worksite health-promotion programs and the costs of hospital admission would be expected, if any.

One surprising result from the above-mentioned analysis is the finding that some features of comprehensive worksite health programs (namely disease screening and health education initiatives for employees) are independent factors significantly associated with **higher** hospital admission costs. This result is opposed to the expected correlation at first. Certainly, it is impossible to extend this finding based on a non-probabilistic sample of six companies to other companies or industries and assume this finding can be generalized for Brazilian companies and their Human Resources policies. However, this can call attention to the assumption that screening activities and health education initiatives during the initial implementation of a worksite health program may increase awareness on diseases and thus lead to an increased number of hospital admissions, compared to companies that do not adopt these initiatives.

Furthermore, these results raise reasonable questions regarding the planning process and implementation of worksite health education activities and screening initiatives in the studied companies. As described in section 2.4, screening activities should be carefully designed in order to achieve early recognition of disease conditions in a well-defined target population, for which there is adequate available treatment with high prognostic impact and low cost. One of the basic principles that reign over screening activities is that they must have positive outcomes, both related to patient heath and to the costs of healthcare (WILSON; JUNGNER, 1968). Additionally, careful attention must be paid to the consequences (either psychological, physical or economic) of overdiagnosis and overtreatment of diseases that would otherwise not be diagnosed or be diagnosed at later stages (HARRIS et al., 2011).

In the present study, details about the extent, design and implementation of worksite screening programs were outside the scope of the survey, which merely focused on the presence or absence of screening activities in the company's health program. However, if the finding that health education and screening activities are associated with higher hospital admission costs can be further demonstrated and validated in larger samples with improved internal validity, then one can fairly assume that worksite education and screening activities are leading to awareness and diagnosis of diseases in a manner non-adherent to the basic principles outlined in section 2.4. The results found in the present model, with the inference of higher hospital admission costs related to the adoption of health education and screening activities (and if validated by further research, preferably with larger probabilistic

samples), may lead to the conclusion that worksite health program screening activities are not adequately designed and implemented and, therefore, should not be undertaken as they currently are.Some possible explanations for this effect may lie on the ethically discussed practice of providing screening exams for individuals requiring them with insufficient evidence to support screening adoption (according to Wilson's and Jugner's principles), and the practice of screening exams induced by healthcare professionals or institutions (BURGER; KASS, 2009; SEGURA-BENEDICTO, 2006). This concern may be especially important when analyzing the practice some companies have of contracting hospitals to implement very comprehensive screening 'check-ups' that may not abide by the classical principles discussed. This may also be a mechanism involved in the existence of higher hospital admission costs in companies that adopt organized screening activities for their employees, especially if one considers that private hospitals (who often supply employee health screening activities to companies) are incentivized to drive the diagnosis of diseases that may lead to hospital admissions, even though they might not fulfill Wilson's and Jugner's widely accepted criteria for screening.

When the proportion of male employees who had at least one episode of medical leave during the 12-month period of this study was analyzed for the only two companies for which these numbers were available, the proportions were significantly different between these companies.

When we analyze the features of worksite health programs adopted at those two organizations (companies II and III), the significantly lower medical leave proportion happened in the company with activities dedicated to control of bad health habits (such as alcohol and tobacco abuse and the absence of areas for smoking in-company), high blood pressure and diabetes control, and the inclusion of program adherence into employee performance analysis and adoption of financial incentives to stimulate employee adherence. This outcome was quite expected, since these features of worksite health-related programs are expected to drive better health outcomes and lead to lower incidence of medical leaves.

On the other hand, higher medical leave proportions happened in the company that adopted disease screening activities for its employees. Although two companies are certainly not enough to drive conclusive remarks on predictors of medical leave incidence

for Brazilian organizations, and a great number of confounding factors may be present to harm the internal validity of these conclusions, this finding is in line with the previous analysis that described that the adoption of screening activities are significantly associated to higher hospital admission costs. This can be further evidence and confirmation that disease screening activities adopted at this company may lead to worse economic outcomes (of course, this should be further validated through a more comprehensive random sample of companies from diverse industries).

Certainly, the sample of six companies from six different industries included in this research is not at all comprehensive or representative of the Brazilian economy, and the results described cannot be used as general predictors of hospital admission costs or medical leave incidence for companies in Brazil. However, this is a first academic initiative based on a sample of organizations with data encompassing a large number of employees. As long as known by the author, this is an unprecedented academic initiative in Brazil, and thus may contribute to the knowledge in the field.

Further research initiatives certainly may contribute further to this knowledge and lead to more precise identification of features associated to lower healthcare costs, higher returns on health program investments for companies in Brazil and better health indicators for their employees. Especially, the construction of a larger and probabilistic sample of companies in Brazil, encompassing the diverse industries, is highly desirable, and could produce more reliable results with higher internal and external validity.

Ideally, such large well-constructed sample of Brazilian companies would make a cross-sectional study of this subject appropriate, leading to more powerful conclusions on the possible association of characteristics of worksite health promotion programs and their impact on companies' healthcare-related costs. Furthermore, a sample of companies with larger follow-up periods would make an adequate longitudinal study possible, with more powerful conclusions on the relations of worksite health program characteristics and their results.

Nonetheless, even though this present study has numerous potential threats to internal validity and to external generalization (as discussed above), the surprising results regarding a possible positive correlation between health education and disease screening

initiatives by big Brazilian companies and their employees' hospital admission costs poses an interesting question that recommends and invites further research.

Additional research initiatives that address the adequacy of the health education and disease screening activities undertaken by companies in Brazil, and that can isolate these activities in order to study their respective economic returns would be of utmost importance, in order to further clarify and try to validate the results presented herein.

9. References

NATIONAL CENTER FOR HEALTH STATISTICS. **Healthy People 2010: final review.** [s.l: s.n.].

ADAMS, J. et al. A systematic review of the use of financial incentives and penalties to encourage uptake of healthy behaviors: protocol**. Systematic Reviews**, 2012.

ALBUQUERQUE, L. G.; LIMONGI-FRANÇA, A. C. Estratégias de recursos humanos e gestão da qualidade de vida no trabalho: o stress e a expansão do conceito de qualidade total. **Revista de Administração**, v. 33, n. 2, p. 40-51, 1998.

ANDERMANN, A. et al. Revisiting Wilson and Jungner in the genomic age: A review of screening criteria over the past 40 years**. Bulletin of the World Health Organization**, 2008.

ARCAVI, L.; BENOWITZ, N. L. Cigarette smoking and infection. **Archives of internal medicine**, v. 164, p. 2206–2216, 2004.

ARIELY, D. et al. Large Stakes and Big Mistakes. **Review of Economic Studies**, v. 76, n. 2, p. 451–469, abr. 2009.

BABU, A. S. et al. Worksite health and wellness programs in India. **Progress in Cardiovascular Diseases**, v. 56, p. 501–507, 2014.

BAICKER, K.; CUTLER, D.; SONG, Z. Workplace wellness programs can generate savings. **Health Affairs**, v. 29, p. 304–311, 2010.

BARLOW, D. H.; HAYES, S. C. Alternating treatments design: one strategy for comparing the effects of two treatments in a single subject. **Journal of Applied Behavior Analysis**, v. 12, p. 199–210, 1979.

BAXTER, S. et al. The relationship between return on investment and quality of study methodology in workplace health promotion programs. **American Journal Of Health Promotion** , v. 28, p. 347–63, 2014.

BERK, R. A. **An Introduction to Sample Selection Bias in Sociological DataAmerican Sociological Review**, 1983.

BOULT, C. et al. Screening elders for risk of hospital admission. **Journal of the American Geriatrics Society**, v. 41, n. 8, p. 811–817, 1993.

BRACHT, G. H.; GLASS, G. V. The External Validity of Experiments**. American Educational Research Journal**, 1968.

BRANCH, L. et al. Toward understanding elders' health service utilization. **Journal of Community Health**, v. 7, p. 80–92, 1981.

BURGER, I. M.; KASS, N. E. Screening in the dark: ethical considerations of providing screening tests to individuals when evidence is insufficient to support screening populations. **The American Journal of Bioethics** , v. 9, p. 3–14, 2009.

CALLUM, C.; BOYLE, S.; SANDFORD, A. Estimating the cost of smoking to the NHS in England and the impact of declining prevalence. **Health Economics, Policy, and Law**, v. 6, p. 489–508, 2011.

CAMPBELL, D. T. Factors relevant to the validity of experiments in social settings. **Psychological Bulletin**, v. 54, p. 297–312, 1957.

CHAPMAN, L. S. Meta-Evaluation of Worksite Health Promotion Economic Return Studies : 2012 Update Setting the Stage. **American Journal of Health Promotion**, v. 26, n. April, p. 1–11, 2012.

CHENAIL, R. J. Interviewing the investigator: strategies for addressing instrumentation and researcher bias concerns in qualitative research. **The Qualitative Report**, v. 16, p. 255–262, 2011.

COHEN, J.; COHEN P.; WEST, S.G.; AIKEN, L. **Applied Multiple Regression / Correlation Analysis for the Behavioral Sciences**. 2 ed., Hillsdale, NJ, Lawrence Erlbaum Associates, 1983.

COX, J. S. Drug abuse in the workplace. **Paper 360**, v. 3, p. 32–33, 2008.

CUDDEBACK, G.; WILSON, E.; ORME, J.G.; COMBS-ORME, T. Detecting and Statistically Correcting Sample Selection Bias. **Journal of Social Service Research**, v. 30, p. 19–33, 2004.

DELGADO-RODRÍGUEZ, M.; LLORCA, J. Bias. **Journal of Epidemiology and Community Health**, v. 58, p. 635–641, 2004.

EISENBERGER, R.; PIERCE, W. D.; CAMERON, J. Effects of reward on intrinsic motivation—Negative, neutral, and positive: Comment on Deci, Koestner, and Ryan (1999). **Psychological Bulletin**, v. 125, n. 6, p. 677–691, 1999.

EMMONS, K. M.; LINNAN, L.A.; SHADEL, W.G.; MARCUS, B.; ABRAMS, D.B. The Working Healthy Project: a worksite health-promotion trial targeting physical activity, diet, and

smoking. **Journal of Occupational and Environmental Medicine**, v. 41, n. July 1999, p. 545–555, 1999.

EPSTEIN, A M.; CUMELLA, E. J. Capitation payment: using predictors for medical utilization to adjust rates. **Health Care Financing Review**, v. 10, n. 1, p. 51–69, 1988.

EVASHWICK, C.; ROWE, G. DIEHR, P. BRANCH, L. Factors explaining the use of health care services by the elderly. **Health Services Research**, v. 19, n. 3, p. 357–382, 1984.

FINKELSTEIN, E. A. BROWN, D.S.; BROWN, D.R.; BUCHNER, D.M. A randomized study of financial incentives to increase physical activity among sedentary older adults. **Preventive Medicine**, v. 47, n. 2, p. 182–7, ago. 2008.

GAY, L. R.; MILLS, G.; AIRASIAN, P. **Educational Research: Competencies for Analysis and Applications**, 3 ed., New Jersey, Pearson, 2011.

GILES, E. L. ROBALINO, S.; McCALL, E.; SNIEHOTTA, F.F.; ADAMS, J. The effectiveness of financial incentives for health behaviour change: Systematic review and meta-analysis. **PLoS ONE**, v. 9, n. 3, p. 1-16, 2014.

GNEEZY, U.; MEIER, S.; REY-BIEL, P. When and Why Incentives (Don't) Work to Modify Behavior. **Journal of Economic Perspectives**, v. 25, n. 4, p. 191–210, nov. 2011.

GNEEZY, U.; RUSTICHINI, A. Pay Enough or Don't Pay at All. **The Quarterly Journal of Economics**, v. 115, p. 791–810, 2000.

GOETZEL, R. Z.; ANDERSON, D.R.; WHITMER, R.W.; OZMINKOWSKI, RJ.; DUNN, R.L.; WASSERMAN, J. The relationship between modifiable health risks and health care expenditures. An analysis of the multi-employer HERO health risk and cost database. **Journal of Occupational and Environmental Medicine / American College of Occupational and Environmental Medicine**, v. 40, p. 843–854, 1998.

GOLAFSHANI, N. Understanding reliability and validity in qualitative research. **The Qualitative Report**, v. 8, p. 597–607, 2003.

HAAS, D. F.; KRAFT, D. H. Experimental and quasi-experimental designs for research in information science. **Information Processing & Management**, v. 20, n. 1-2, p. 229–237, jan. 1984.

HALL, B. Good Health Pays Off! Fundamentals of Health Promotion Incentives. **Journal of Deferred Compensation**, v. 11, n. 2, p. 16–27, 2005.

HALL, B. Health incentives: the science and art of motivating healthy behaviors. **Benefits Quarterly**, v. 24, p. 12–22, 2008.

HALPERIN, W. E.; RATCLIFFE, J.; FRAZIER, T.M.; WILSON, L. BECKER, S.P.; SCHULTE, P.A. Medical screening in the workplace: proposed principles. **Journal of Occupational**

Medicine. v. 28, n. 8, p. 547-552, 1986.

HARRIS, R.; SAWAYA, G.F.; MOYER, V.A.; CALONGE, N. Reconsidering the criteria for evaluating proposed screening programs: Reflections from 4 current and former members of the U.S. preventive services task force. **Epidemiologic Reviews**, v. 33, p. 20–35, 2011.

HERMAN, C. What Makes a Screening Exam. **Virtual Mentor**, v. 8, p. 34–37, 2006.

HERMAN, P. M.; WALSH, M. E. Hospital admissions for acute myocardial infarction, angina, stroke, and asthma after implementation of Arizona's comprehensive statewide smoking ban. **American Journal of Public Health**, v. 101, p. 491–496, 2011.

HERNÁN, M. A.; HERNÁNDEZ-DÍAZ, S.; ROBINS, J. M. A Structural Approach to Selection Bias. **Epidemiology**, v. 15, n. 5, p. 615-625, 2004.

HINKELMANN, K.; KEMPTHORNE, O. Principles of Experimental Design. In: **Design and Analysis of Experiments, Volume 1 - Introduction to Experimental Design**. 2. ed., John Wiley and Sons, p. 29–60, 2008.

KRONENFELD; J.J.; BLAIR, S.N.; DAVIS, K.; GIMARC, J.D.; SALISBURY, Z.; MAYSEY, D.; McGEE, K. J. Evaluating Health Promotion: A Longitudinal Quasi-Experimental Design. **Health Education Behavior**, v. 14, n. 2, p. 123, 1987.

KAMENICA, E. Behavioral Economics and Psychology of Incentives. **Annual Review of Economics**, v. 4, n. 1, p. 427–452, jul. 2012.

KIRSTEN, W. Making the Link between Health and Productivity at the Workplace —A Global Perspective. **Industrial Health**, v. 48, p.251-255, 2010.

LEEKS, K. D.; HOPKINS, D.P.; SOLER, R.E.; ATEN, A.; CHATTOPADHYAY, S.K. Worksite-Based Incentives and Competitions to Reduce Tobacco Use. A Systematic Review. **American Journal of Preventive Medicine**, v. 38, p. S263-S274, 2010.

LINNAN, L.; BOWLING, M.; CHILDRESS, J.; LINDSAY, G.; BLAKEY, C.; PRONK, S.; WIEKER, S.; ROYALL, P. Results of the 2004 National Worksite Health Promotion Survey. **American Journal of Public Health**, v. 98, n. 8, p. 1503–9, ago. 2008a.

LOEWENSTEIN, G.; BRENNAN, T.; VOLPP, K. G. Asymmetric paternalism to improve health behaviors. **Journal of the American Medical Association**, v. 298, p. 2415–2417, 2007.

LORIG, K.; KRAINES, R.G.; BROWN, B.W.; RICHARDSON, N. A workplace health education program that reduces outpatient visits. **Medical Care**, v. 23, n. 9, p. 1044–1054, 1985.

MACDONALD, S.; CSIERNIK, R.; DURAND, P.; RYLETT, M.; WILD, T.C. Prevalence and factors related to Canadian workplace health programs. **Canadian Journal of Public Health**, v. 97, p. 121–5, 2006.

MATTKE, S.; LIU, H.; CALOYERAS, J.P.; HUANG, C.Y.; Van BUSUM, K.R.; KHODYAKOV, D.;

SHIER, V. Workplace Wellness Programs Study Final Report. RAND Corporation, Santa Monica, CA, 2013.

NETER, J.; KUTNER, M.H.; NACHTSHEIM, C.J.; WASSERMAN, W. **Applied Linear Statistical Models**. 4. ed., Richard D Irwin Inc., Chicago, 1996.

NEUBAUER, S.; WELTE, R.; BEICHE, A.; KOENIG, H.H.; BUESCH, K.; LEIDL, R. Mortality, morbidity and costs attributable to smoking in Germany: update and a 10-year comparison. **Tobacco Control**, v. 15, p. 464–71, 2006.

NUTBEAM, D. Health literacy as a public health goal: a challenge for contemporary health education and communication strategies into the 21st century. **Health Promotion International**, v. 15, n. 3, p. 259–267, 2000.

OLIVEIRA, P. M.; LIMONGI-FRANÇA, A. C. Avaliação da gestão de programas de qualidade de vida no trabalho. **RAE Eletrônica,** v. 4, n. 1, Art. 9, Jan/Jul, 2005.

O'DONNELL, M. P. Financial incentives for workplace health promotion: What is equitable, what is sustainable, and what drives healthy behaviors? **American Journal of Health Promotion**, v. 26, 2012.

ONWUEGBUZIE, A. J. Expanding the framework of internal and external validity in quantitative research. **Research in the Schools**, v. 10, p. 71–89, 2003.

PAPERWALLA, K. N.; LEVIN, T.T.; WEINER, J.; SARAVAY, S.M. Smoking and depression. **The Medical Clinics of North America**, v. 88, p. 1483–94, x–xi, 2004.

PEGUS, C.; BAZARRE, T.L.; BROWN, J.S.; MENZIN, J. Effect of the Heart At Work program on awareness of risk factors, self-efficacy, and health behaviors. **Journal of Occupational and Environmental Medicine**, v. 44, n. 3, p. 228–36, 2002.

PROMBERGER, M.; MARTEAU, T. M. When do financial incentives reduce intrinsic motivation? Comparing behaviors studied in psychological and economic literatures. **Health Psychology** , v. 32, p. 950–7, 2013.

PURNELL, J. Q.; GERNES, R.; STEIN, R.; SHERRADEN, M.S.; KNOBLOCK-HAHN, A. A systematic review of financial incentives for dietary behavior change. **Journal of the Academy of Nutrition and Dietetics**, v. 114, p. 1023–1035, 2014.

RAJU, N. S.; BILGIC, R.; EDWARDS, J.E.; FLEER, P.F. Methodology review: Estimation of population validity and cross-validity, and the use of equal weights in prediction. **Applied Psychological Measurement**, v. 21, p. 291–305, 1997.

RAMIARINA, R.; ALMEIDA, R. M.; PEREIRA, W. C. Hospital costs estimation and prediction as a function of patient and admission characteristics. **International Journal of Health Planning and Management**, v. 22, n. 1, p. 25–44, 2007.

REISER, S. J. The emergence of the concept of screening for disease. **The Milbank Memorial Fund Quarterly. Health and society**, v. 56, p. 403–25, 1978.

RIVERA, B.; CURRAIS, L. Economic growth and health: direct impact or reverse causation? **Applied Economics Letters**, v. 6, p. 761–764, 1999.

RONGEN, A. ROBROECK, S.J.W.; Van LENTHE, F.J., BURDORF, A. Workplace health promotion: A meta-analysis of effectiveness. **American Journal of Preventive Medicine**, v. 44, p. 406-415, 2013.

SEGURA-BENEDICTO, A. Inducción sanitaria de los cribados: impacto y consecuencias. Aspectos éticos. **Gaceta Sanitaria**, v. 20, p. 88-95, 2006.

SUTHERLAND, K.; CHRISTIANSON, J. B.; LEATHERMAN, S. Impact of targeted financial incentives on personal health behavior: a review of the literature. **Medical Care Research and Review** , v. 65, n. 6 Suppl, p. 36S–78S, dez. 2008.

WAN, T. T. H.; ODELL, B. G. Factors Affecting the Use of Social and Health Services Among the Elderly. **Ageing and Society**, v. 1, n. 01, p. 95, 14 nov. 2008.

WILSON, J. M.; JUNGNER, Y. G. Principles and practice of mass screening for disease. **Boletin de la Oficina Sanitaria Panamericana. Pan American Sanitary Bureau**, v. 65, p. 281–393, 1968.

WWW.ASH.ORG.UK. Smoking and mental health. **Action on Smoking and Health**, p. 1–12, 2013.

ZHOU, Z. et al. Survival bias associated with time-to-treatment initiation in drug effectiveness evaluation: A comparison of methods. **American Journal of Epidemiology**, v. 162, p. 1016–1023, 2005.

10. Appendices

APPENDIX 1 – Questionnaire on Worksite Health Promotion Programs

This section presents the questionnaire that was designed and sent to senior Human Resources managers of the seven included companies, inviting and asking for their participation in the present study.

All participants were notified that their answers, if they decided to participate in the research, would be analyzed by a researcher in order to produce an academic work, without any economic or financial benefits.

All participants allowed their responses to be correlated to data kept by the data provider regarding their healthcare-related costs and indicators, for the sole purpose of academic research.

Researchers and the data provider's staff formally assured respondents that their identities and the names of the companies they represent, as well as data regarding individual responses and individual data on their employees would not be disclosed. The researchers assured them only aggregate data and unidentified company names would be published.

The questionnaire (in Portuguese) was as follows:

1) Nome da empresa:

2) Email do respondedor:

3) Possui programa organizado de saúde e bem-estar?

- Sim
- Não

4) Se sim, quais das seguintes atividades são incluídas no programa?

- Controle de pressão arterial
- Controle de etilismo
- Controle de diabetes
- Cessação de tabagismo
- Promoção de atividade física
- Promoção de alimentação saudável
- Promoção de perda de peso / controle de obesidade
- Exames de *screening* / *check-up* periódico apenas para cargos de liderança
- Exames de *screening* / *check-up* periódico para todos os funcionários
- Programa de medicação de uso contínuo
- Programa de horário flexível (home office)
- Programa de Assistência Pré Natal
- Programa de Assistência ao Empregado (educação financeira, jurídica e pessoal)
- Programa de combate a *stress* (por favor, especifique)
- Outros: _____

5) Quando foi iniciado este programa de saúde e bem-estar?

6) A empresa utiliza dados colhidos no programa para guiar a tomada de decisões gerenciais?

- Sim
- Não

7) Sobre as atividades do programa de saúde e bem-estar:

- São oferecidas e custeadas como parte do pacote de benefícios a todos os funcionários
- São organizadas e custeadas pela seguradora/operadora de saúde suplementar
- São organizadas e custeadas conjuntamente pela empresa e funcionários

8) Aderência e participação são parte das metas de avaliação de performance de funcionários?

- Sim
- Não

9) Utiliza incentivo financeiro à aderência de funcionários ao programa?

- Sim (Ex.: PLR, bônus, premiação financeira etc)
- Não

10) Utiliza incentivo não financeiros à aderência de funcionários ao programa?

- Viagens
- Competições
- Outras premiações: _____

11) Quem recebe os incentivos descritos?

- Todos os funcionários
- Todos os participantes
- Aqueles que atingem metas

12) A empresa disponibiliza para os seus funcionários:

- Espaço para atividade física na própria empresa
- Chuveiros
- Convênio com academia externa
- Refeitório
- Área reservada para fumantes

13) Quantos funcionários a empresa tem alocados exclusivamente para a gestão do programa?

- Nenhum
- 1 a 3
- 4 a 6
- 7 ou mais

14) O programa inclui qual (is) das seguintes características?

- Educação sobre saúde para funcionários
- Ambiente de trabalho fisicamente e socialmente voltado a promoção de atitudes saudáveis e prevenção de doenças
- Integração do programa à estrutura da organização
- Ligação do programa de saúde a outros programas da empresa (tais como assistência médica)
- Programas de *screening* e rastreamento de doenças no ambiente de trabalho?

15) Gostaria de receber o resultado desta pesquisa?

- Sim
- Não

APPENDIX 2 – Criteria for classification of health insurance coverage for subjects included

Since hospital admission costs vary substantially among different providers, even for the same standardized procedures, ideally these costs should be controlled in a regression model like the one built in this research by the hospital chosen for every patient admission. However, this would lead to an enormous and very complex amount of information, which would make its inclusion not feasible.

Thus, as pointed out in section 4.2.1, this independent variable was substituted by a stratification of health plan type provided by the companies. This is based on the assumption that employees, when patients in need of hospital procedures or admissions, tend to choose among the best hospital alternatives available through their health plan coverage, with great correlation with hospital admission costs.

Health plans provided by employees were stratified into three different categories:

i. Premium health plans: Regardless of the name of health insurance provider, these premium plans were defined as those that cover admission to hospitals that only provide individual apartment accommodations.

   Most private hospitals in Brazil (here defined in this criteria as basic hospitals) have two categories of inpatient admission accommodations, both individual apartment and collective room accommodations. However, some higher-level (and higher-cost) hospitals only offer individual apartment accommodation to inpatients. In this criteria, those are defined as 'premium' hospitals.

   For the purposes of health plan stratification, plans that cover admission to one or more of these 'premium' hospital chains are defined herein as 'premium health plans'.

ii. Basic health plans with individual apartment accommodation: Regardless of the health insurance provider, some plans cover hospital admissions with private apartment accommodations, but do not cover admissions into 'premium' hospitals as described above. In other words, these plans provide patients accommodation into private apartment accommodations when hospital admission is needed, but those hospitals are not 'premium' ones (those that do

not have collective rooms for inpatients). For the purpose of this research, these health plans were categorized as “basic health plans with individual apartment accommodation”.

iii. Basic health plans with collective accommodation: The majority of health plans offered by employees to the Brazilian population cover only admission to basic hospitals (as described above), and in collective inpatient rooms. Of course, these are hospitals categorized as ‘basic’ through the criteria described above.

This category encompasses all the patients with health plans that cover only hospital admission to collective inpatient rooms.

Abbreviates used in this text

EPO: Exclusive Provider Organization

EPOs are organizations that provide or arrange health insurance for patients, in which a primary care physician is not necessarily included in the treatment of every patient as a *gatekeeper*. In EPO structures, patients in need of hospital admission, physician office visits or diagnostic procedures may look for whatever service they need without referral from a primary care physician. However, every care provider must be seen inside a predetermined provider network.

Thus, this type of plan does not cover health expenses provided out of the predetermined network, and patients cannot freely choose among every healthcare provider.

PPO: Preferred Provider Organization

Like EPOs described above, PPOs are health insurance organizations that let patients look for healthcare services without prior referral by a primary care physician (or *gatekeeper*). However, EPOs offer patients the possibility of choosing among healthcare providers outside a predetermined network. Patients can be reimbursed for healthcare expenditures outside the provider network by so-called PPOs.