Safety and Health at Work 11 (2020) 26–32

Contents lists available at ScienceDirect

Safety and Health at Work

journal homepage: www.e-shaw.net

Original Article

Patterns of Cancer-Related Risk Behaviors Among Construction Workers in Hong Kong: A Latent Class Analysis Approach

Nan Xia, Wendy Lam, Pamela Tin, Sungwon Yoon, Na Zhang, Weiwei Zhang, Ke Ma, Richard Fielding*

Centre for Psycho-Oncology Research and Training, School of Public Health, The University of Hong Kong, 2/F, Patrick Manson Building (North Wing), 7 Sassoon Road, Pokfulam, 999999, Hong Kong

ARTICLE INFO

Article history:
Received 1 October 2019
Received in revised form
18 November 2019
Accepted 26 December 2019
Available online 7 January 2020

Keywords:
Cancer
Construction workers
Prevention
Risk behaviors

ABSTRACT

Background: Hong Kong's construction industry currently faces a manpower crisis. Blue-collar workers are a disadvantaged group and suffer higher levels of chronic diseases, for example, cancer, than the wider population. Cancer risk factors are likely to cluster together. We documented prevalence of cancer-associated lifestyle risk behaviors and their correlates among Hong Kong construction workers.

Methods: Data were collected from workers at 37 railway-related construction worksites throughout Hong Kong during May 2014. Tobacco use, alcohol consumption, unbalanced nutrition intake, and physical inactivity were included in the analysis. Latent class analysis and multivariable logistic regression were performed to identify the patterns of risk behaviors related to cancer, as well as their impact factors among construction workers in Hong Kong.

Results: Overall, 1,443 workers participated. Latent class analysis identified four different behavioral classes in the sample. Fully adjusted multiple logistic regression identified age, gender, years of Hong Kong residency, ethnicity, educational level, and living status differentiated behavioral classes.

Conclusion: High levels of lifestyle-related cancer-risk behaviors were found in most of the Hong Kong construction workers studied. The present study contributes to understanding how cancer-related lifestyle risk behaviors cluster among construction workers and relative impact factors of risk behaviors. It is essential to tailor health behavior interventions focused on multiple risk behaviors among different groups for further enlarging the effects on cancer prevention.

1. Introduction

In Hong Kong, the construction industry faces a serious manpower shortage due to population aging [1] and the unattractiveness of outdoor manual labor compared to alternatives [2]. Consequently, ensuring the existing construction workforce remains healthy also helps maintain workforce participation [3] and postpones early retirement on health grounds [4], as well as benefitting workers directly.

Blue-collar workers are a disadvantaged socioeconomic group who tend to suffer higher levels of chronic diseases [5]. Previous studies indicate that construction workers are more likely to suffer health problems [6] and have health complaints [7]. For example, a study conducted in the United States reported that construction workers had higher risks of foot/leg problems, back problems, and chronic lung diseases comparing with white-collar workers and other blue-collar workers such as service employees and machinery operators [7].

Workforce chronic diseases and associated poor health outcomes reflect not only occupational exposures but also lifestyle and personal characteristics as well [8]. These increase overall health risks independent of occupational-specific hazards. The leading causes of death in Hong Kong are malignant neoplasms in both males and females, closely followed by pneumonia and heart diseases [9]. Tobacco use, excessive alcohol consumption, unhealthy diet, and physical inactivity are important chronic disease risk behaviors, particularly regarding cancer [10]. Multiple chronic disease risk behaviors habitually cluster together within one individual rather than exist in a solitary fashion [11,12]. In the United States, less than 5% of U.S adults evidence healthy lifestyles regarding

* Corresponding author. 2/F, Patrick Manson Building (North Wing), 7 Sassoon Road, Pokfulam, 999999, Hong Kong. Fax: +852 2855 9528.
E-mail address: fielding@hku.hk (R. Fielding).

2093-7911/$ – see front matter
https://doi.org/10.1016/j.shaw.2019.12.009

tobacco abstinence, healthy diet, proper weight control, regular physical activity, and low alcohol consumption [13]. Studies conducted in Hong Kong revealed that around 70% of the older population had at least one lifestyle risk factor, and males are more prone to such risk behaviors compared with women [14]. Among a sample of Hong Kong construction workers, around 40% were previously reported to be current smokers, whereas more than 30% reported drinking alcohol [15]. Negative lifestyle behaviors, such as smoking, contribute to a similar degree as do occupational factors to sickness absence [16]. However, the risks from chronic diseases and their related risk behaviors are readily overlooked as the construction industry in general holds a negative culture toward health promotion [17]. Currently, no study has investigated other cancer-related risk behaviors such as diet and physical activities among Hong Kong's blue-collar workers or how risk prevalence varies within groups.

To better understand lifestyle-related cancer-related risk behaviors among a group of blue-collar workers, we sampled Hong Kong construction workers in collaboration with a large infrastructure provider. We assessed the risk behavior prevalence and then identified potential risk behavior clusters among a sample of construction workers. Finally, we examined which sociodemographic factors were associated with different risk clusters.

2. Materials and methods

In May 2014, the Hong Kong Mass Transit Corporation (MTR), which is extensively developing Hong Kong's subway system launched a "Worker Health and Well-being Month". Over a total of 37 different subcontracted construction worksites across Hong Kong, 71 on-site one-hour health screening and promotion sessions were implemented. During each session, on-site data collection was conducted using a standardized questionnaire and data collection protocols. Subcontracted construction workers [frontline skilled, semiskilled or unskilled (laborers) tradesmen working at the infrastructure worksites] (Appendix A) were released in 30 min batches for assessment over the course of each morning/afternoon session each lasting between 3 and 4 h.

We assessed four cancer-related health risk behaviors (HRBs): tobacco use, alcohol binge drinking, unhealthy diet, and physical inactivity (10). These were operationalized as follows: usual daily smoking, usual daily/weekly alcohol consumption, weekly frequency of fruit, vegetable and red meat consumption, and leisure-time physical inactivity on weekdays and on weekends/holidays.

Tobacco smoking was assessed by asking "Have you ever smoked cigarettes?" Four possible response options were: daily smoker ($\geq$1 cigarette/day), occasional smoker (less than one cigarette per day), former smoker (for previous smokers who had now quit for $>$1 month), and never smoked. Respondents indicating the first two options were classed as a current smoker.

The Alcohol Used Disorder Identification Test (AUDIT-Consumption) (AUDIT-C) was used to collect data on alcohol consumption [18]. The instrument consists of three items, two of which collected information on drinking frequency from never (0) to four times a week or more (4) and frequency of drinking more than five drinks per occasion, from never (0) to every day or almost every day (4). Individuals also report the type (beer/wines/spirits) and amount of drinking each session. Possible total AUDIT-C scores range from 0 to 12, and participants scoring five or more points are identified as high-risk drinkers [19].

Data on the weekly frequency of fruit, vegetable, and red meat consumption were collected to estimate habitual dietary behaviors. Two questions, "On average, how many days do you eat (fruit/vegetables) within a week" were used to evaluate participants' frequency of fruits and vegetable consumption. Possible responses were "less than one day/week", "one day/week", "two to three days/week", "four to five days/week", and "six to seven days/week". Those who indicated the frequency of eating either fruit or vegetables on less than four days per week were categorized as having low fruit/vegetables consumption.

Consumption of red meat was similarly evaluated using the question "How many days on average do you eat pork, beef or lamb each week?" Possible responses were "less than one day/week", "one day/week", "two to three days/week", "four to five days/week", and "six to seven days/week". Those who reported eating more than five days of pork, beef or lamb per week were considered as comprising a high-risk group.

Two questions evaluated how physically active respondents were during weekday, weekend, and public holiday leisure time. Previous studies conventionally classified individuals who were active less than once per week as physically inactive [20]. In the present study, we defined physical inactivity by daily level, and respondents reporting sedentary activities including watching television, playing mahjong, or other physically inactive pastimes for more than two hours per day during weekdays/weekends and public holidays were classified as inactive. Physical inactivity during weekdays/weekends and public holidays was defined as being inactive (for example, watching television, playing mahjong, or other sedentary activities) for more than two hours per day.

Sociodemographic information was also collected including age, gender, ethnicity, educational level, monthly household income, years of living in Hong Kong, living condition, housing type, marital status, and number of children.

Latent class analysis (LCA) is a structural equation-based approach for identifying mutually exclusive latent classes within the observed population [21]. Compared with other methodologies of cluster analysis, a major benefit of LCA is that the most appropriate class solution for the data can be identified not a priori but based on statistical indices and tests (19). Because of the advantages of LCA, this methodology is increasingly applied in the public health field to analyze patterns of risk behaviors [22].

In LCA, the number of classes is determined based on an exploratory process starting with a single-class model. The model with "n+1" classes is compared against the model with "n" classes, using different statistical indices that include Bayesian information criterion (BIC), adjusted Bayesian information criterion (aBIC), and entropy value among others. The optimum number of classes is determined when the values for these indices reach their respective fit optima. In this study, the number of classes was determined using the BIC, the aBIC, the entropy value, and the results of the Lo–Mendell–Rubin likelihood ratio test. The BIC and adjusted BIC was applied because the simulation study demonstrated that these two indices were more accurate in determining the number of classes in the LCA under the circumstance of large sample size ($N = 1000$) [23]. The smaller value of the BIC indicates a better model fit and same as the aBIC [21]. The entropy values range from 0 to 1, and the higher value represents better model fit [24]. The Lo–Mendell–Rubin test was equipped to explore the optimal number of classifications based on the improvement in fit between models [25]. The analysis was conducted using MPlus, version 6.0 [26].

Multivariable logistic regression was then performed to examine the association between sociodemographic characteristics and class membership, using SPSS 20.0 [27].

Participation in this study was voluntary. After ethical approval from the Institutional Review Board of the University of Hong Kong/Hospital Authority Hong Kong West Cluster (IRB reference number: UW 14-416), all participants provided fully informed written consent to participate. Because this study was part of a free activity coordinated by the MTR to benefit the maximum number of

workers, no exclusion criteria were set other than participants had to be employees of contractors delivering MTR infrastructural projects.

3. Results

During 71 sessions, 1,443 construction workers participated in the study (averaging 10 per 30 min slot), having a mean age of 44.9 years (SD = 11.5), with 82.5% being male, 78.6% were Chinese, 81.3% were married or cohabited, and 63.7% had one or two children. On average respondents had lived in Hong Kong for 24.5 years (SD = 17.38). Most participants (63.4%) completed lower or upper secondary education, whereas 30.5% reportedly received no or only primary education. Most participants' (65.6%) reported monthly household income below Hong Kong $25,000 (~US$3,000). Sample characteristics are summarized in Table 1.

Table 2 reports the prevalence of the seven risk behaviors included in the LCA analysis. Measured risk behavior prevalence ranged from a low value of 15.2% (excessive or binge drinking) to 48.7% (leisure-time inactivity on weekends). The results of Lo–Mendell–Rubin test, the value of aBIC, parsimony, and model interpretation further illustrated that the four latent class model provided the best and most parsimonious model fit to data as the four class model provided significant improvement in model fit over the 3-class model and achieved the lowest aBIC.

The four distinct classes were identified by LCA based on the response probability for each risk behavior (Table 3), and individuals from different classes demonstrated various risk patterns. Class 1, (33.9% of respondents), captured construction workers who had the lowest risk lifestyles (though in some respects still relatively high risk). Individuals within this class reported a lower prevalence of risky behaviors (excessive or binge drinking, 4.5%; smoking, 23.8%; lack of fruit/vegetable intake, 29.9%; high red meat consumption, 30.1%; physical inactivity during weekdays, 0%; and physical inactivity during weekends, 17.3%) comparing with other groups. Members from Class 2, comprising 39.2% of participants, reported a relatively similar prevalence pattern to Class 1 participants but lower excessive or binge drinking (2.7%), more smoking (37.0%), similar lack of fruit/vegetable intake (32.8%), and higher red meat consumption (41.4%). However, members from this group reported high levels of physical inactivity during weekdays (56.3%) and weekends (83.0%). Class 3 participants (20.3% of participants) evidenced both greater smoking (66.4%) and much lower vegetable or fruit intake (82.2%). Class 4 (6.5% of respondents) captured workers having the highest reported prevalence of risky behaviors overall (excessive or binge drinking, 54.7%; smoking, 64.6%; lack of fruit/vegetable intake, 71.3%; high red meat consumption, 50.8%; physical inactivity during weekdays, 92.0%; and physical inactivity during weekends, 100%).

Using multinomial logistic regression, the associations between sociodemographic characteristics and LCA group membership were estimated (Table 4). Classes 3 and 4 consisted of male participants only. Younger respondents and those who had lived in Hong Kong longer were also more likely to characterize these two groups. Other predictors played different roles within Class 2, Class 3, and Class 4, referenced against Class 1. Educational level and residential status also characterized membership of Class 3 (smoking and less vegetable/fruit intake). Those who only received a primary or lower level of education (odds ratio [OR] = 3.923; 95% confidence interval (CI): 1.514–10.165; $p < 0.01$) or secondary levels of education (OR = 2.847; 95% CI: 1.173–6.909; $p < 0.05$) had a higher probability of being in Class 3 compared with undergraduate or higher educated workers. Respondents living in public rental housing (OR = 0.581; 95% CI: 0.354–0.953; $p < 0.05$) or private permanent housing (OR = 0.346; 95% CI: 0.185–0.648; $p < 0.01$) were less likely to be in Class 3. Within Class 2, (reported higher levels of physical inactivity during weekdays and weekends), Nepalese and other construction workers from overseas had lower risk of physical inactivity compared with their Chinese counterparts. The ORs for these two

Table 1
Demographic characteristics of the 1,443 participants.

Variables	Class 1 (33.9%)	Class 2 (39.2%)	Class 3 (20.3%)	Class 4 (6.5%)	*p* value
Age	45.49	46.08	39.17	43.35	<0.001
Gender					<0.001
Male	363	442	94	289	
Female	120	120	0	0	
Years of Hong Kong residency	22.10	25.40	25.85	26.28	0.003
Ethnicity					<0.001
Chinese	366	486	67	213	
Nepalese	99	65	22	71	
Others	22	14	5	9	
Education					<0.001
Primary	145	193	11	88	
Secondary	305	335	72	196	
Undergraduate and above	33	36	11	8	
Domestic income					0.128
Less than 15,000	112	154	20	57	
15,000–25,000	203	213	44	114	
25,000–40,000	118	139	22	94	
Higher than 40,000	35	47	6	21	
Living status					0.042
Public renting house	259	339	54	162	
Subsidized sale flats	55	54	5	34	
Private permanent housing	109	103	25	47	
Renting outside	59	63	9	48	
Marital status					<0.001
Single	43	83	33	42	
Cohabited/married	424	450	57	237	
Divorced/others	19	31	4	13	
Number of children (Mode)	2	2	2	2	<0.001

Table 2
Prevalence of risk behaviors among Hong Kong construction workers (N = 1,443).

Risk behaviors*	Prevalence (%)
Excess or binge drinking	15.2
Leisure time inactivity—weekdays	28.6
High consumption of red meat	34.5
Smoking	41.1
Lack of fruit or vegetable intake	46.5
Leisure time inactivity—weekends	48.7

*Definition of Risk Behaviors.
Excess or binge drinking: AUDIT-C: total score: 0–12; those who received 5 or higher were considered as inadequate.
Smoking: current smoker or occasional smoker was considered as inadequate.
Lack of fruit or vegetable intake: Those who ate fruits or vegetable lack than four days per week were considered as inadequate.
High consumption of red meat: Those who ate red meat 6–7 days per week were considered as inadequate; leisure time inactivity – weekdays: Those who did sedantary activities more than 2 hours per day were considered as inadequate; leisure time inactivity – weekends: Those who did sedantary activities more than 2 hours per day were considered as inadequate.

Table 3
Probabilities of risk behaviors within each health risk class (N = 1,443).

	Excess or binge drinking	Smoking	Lack of fruit or vegetable intake	High red meat consumption	Leisure time inactivity-weekdays	Leisure time inactivity – weekend
Class 1 – 33.9%	0.045	0.238	0.299	0.301	<0.001	0.173
Class 2 – 39.2%	0.027	0.370	0.328	0.414	0.563	0.830
Class 3 – 20.3%	0.363	0.664	0.822	0.258	0.094	0.285
Class 4 – 6.5%	0.547	0.646	0.713	0.508	0.920	1.000

Table 4
Multiple logistic regression of risk class membership on sociodemographic characteristics.

Variables	Class 2		Class 3		Class 4	
	OR	CI	OR	CI	OR	CI
Age	0.992	0.976–1.008	0.966**	0.948–0.985	0.956**	0.927–0.985
Male*	1.284	0.919–1.795	–		–	
Years of staying in Hong Kong	1.010	1.000–1.019	1.020**	1.008–1.033	1.023*	1.002–1.045
Ethnicity†						
Nepalese	0.552**	0.368–0.826	1.158	0.737–1.819	1.314	0.644–2.681
Others	0.421*	0.190–0.932	0.654	0.262–1.630	1.005	0.271–3.723
Educational level‡						
Primary or below	1.200	0.627–2.300	3.923**	1.514–10.165	0.594	0.184–1.922
Secondary	1.021	0.565–1.847	2.847*	1.173–6.909	0.971	0.391–2.409
Living status§						
Public rental housing	1.024	0.676–1.552	0.581*	0.354–0.953	1.028	0.420–2.515
Subsidized sale flats	0.848	0.484–1.485	0.549	0.286–1.052	0.400	0.107–1.505
Private permanent housing	0.710	0.429–1.177	0.346**	0.185–0.648	1.060	0.388–2.898

*, $p < 0.05$; **, $p < 0.01$; ***, $p < 0.001$.
Class 2—physical inactive; Class 3—smoking/low fruit and vegetable; Class 4—high risk.
OR, odds ratio; CI, confidence interval.
Multivariable logistic regression used backward elimination method. An interaction term age x years of Hong Kong residency was ejected from the final model.
[a] Referent "Class 1".
* Referent "Female".
† Referent "Chinese".
‡ Referent "Undergraduate and higher".
§ Referent "Renting".

ethnicities were 0.552 (95% CI: 0.368–0.826; $p < 0.01$) and 0.421 (95% CI: 0.190–0.932; $p < 0.05$), respectively.

4. Discussion

The aim of this study was to investigate the prevalence and correlates of four cancer-related risk factors among construction workers in Hong Kong: smoking, alcohol binge drinking, unhealthy diet, and physical inactivity. One notable finding from the present study was the high smoking prevalence among construction workers, consistent with results from the previous year that around 40% of construction workers were current smokers [17]. This figure is approximately four times higher than the 10.7% general population smoking prevalence [28]. Over the last decades, a series of measures focused on eliminating unsafe construction working conditions, such as proving protective clothing and tools, developing managerial systems and policies, and safety legislation, and training, have been made across Hong Kong by both government and employers [29–31]. These strategies successfully decreased occupational accident and fatality rates [32]. However, few measures have targeted construction workers' chronic disease lifestyle risk factors, such as smoking. Previous studies have demonstrated that the workplace can be an important setting for starting regular smoking [33]. The findings from the present study emphasize the importance of developing smoking cessation programs specifically for construction workers. Further studies are needed to explore reasons for high smoking prevalence in the construction industry working environments.

Using LCA, four different lifestyle risk clusters were identified in Hong Kong construction workers. Participants from each class had different characteristics. One-third of the workers, mostly female, demonstrated relatively lower risk lifestyles, except for high smoking prevalence. The remaining two-thirds of the sample evidenced at least two concurrent risk behaviors. Class 2, which captured the largest fraction (39.2%) of respondents, was characterized by physical inactivity and smoking. The major cancer-related risk behaviors among individuals in this group were leisure-time physical inactivity, high red meat consumption, and smoking. Class 3 (20.3%) was characterized by respondents who were current smokers and had low vegetable/fruit intakes. The small proportion at highest risk (Class Four) was at high risk from high levels of smoking, excessive alcohol use, unhealthy diet, and physical inactivity.

Compared with Class 1 respondents, younger male respondents were more likely to be allocated in Classes 3 and 4, showing more risk behaviors. Studies in the USA indicated that younger American males are more likely to report nonadherence to health recommendations compared with women [34], our results suggest a similar pattern may exist here. This finding is also consistent with those in an English adult population, where younger age groups were more likely to have more concurrent risk behaviors [35].

Conversely, a longer residency in Hong Kong may itself be a risk factor for exposure to a wider range of risk factors among construction workers. Although Hong Kong has the longest life expectancy worldwide [36] especially for women, chronic morbidity-free life expectancy has decreased sharply in both male and female [37]. It is unlikely that the present population living in Hong Kong has had as healthy a lifestyle as the current elderly population who came in the interwar and postwar years. Cancers are among the leading causes of mortality in Hong Kong [9], and the prevalence is likely to increase as the present middle-aged population moves into later adulthood. Although this segment of the working population is probably not wholly representative, of lower income workers, it is likely that many more will develop lifestyle-related cancers, especially related to lung and lower gastrointestinal tract [38].

Other than gender, age, and duration of Hong Kong residency, educational level and housing type are probably markers for social differences and inequalities, demonstrating the well-documented link between inequality and prevalence of cancer risk behaviors [39], including smoking, alcohol use, inactivity, and poor diet but for different reasons [39]. The association that individuals with higher educational achievement and who were home owners had lower risk behaviors in the present study is consistent with earlier research conducted among western populations [40]. In contrast, the mechanism by which other residential type marks—such an association is unlikely to be causal—cancer-related risk clustering was unclear but may reflect knowledge, cultural or financial factors, or a combination thereof. In some cases, this phenomenon could partly be explained by minority ethnicity. Minorities are well known to be at higher risk of health compromise in a variety of circumstances [41], and this is one of the most consistent findings in the health literature [42]. In the present study, the results suggested that compared with Chinese colleagues, Nepalese construction workers were more likely to be smokers and have unhealthy diet; however, this association did not reach significance.

Compared with immigrant workers, local construction workers were more likely to be physically inactive. This finding is consistent with the claim that Hong Kong people were more likely than people from other countries to spend their leisure time in sedentary activities [43]. Perhaps, this is because in Hong Kong, there is a relatively low prevalence of car ownership although the climate is particularly hot and humid for much of the year, discouraging casual physical activity. In other countries especially western countries, physical activity was more a matter of personal choice for fitness purposes [44]. Moreover, having a physically demanding job means that physical activity at work is likely to offset a desire for leisure activity: people are too tired [44]. Because construction work is frequently physically demanding, it might be unrealistic to expect additional physical activity during leisure time, and in this regard, the indicators of inactivity may be less reliable as a risk because of the high incidence of work-related physical activity in this group.

This study makes a preliminary effort to describe cancer risk behavior clusters, but these risks could also apply to other chronic diseases such as diabetes and circulatory diseases. The different risk clusters characterized in this study illustrate an important approach to identify and characterize the highest risk-clustering groups who can be targeted for interventions.

5. Implications

Using LCA, this study identified four risk clusters and associated lifestyle profiles among a large sample of Hong Kong construction workers. Importantly, in most cases, these cancer-related HRBs were clustered together, amplifying likely cancer risk in a complex, probably multiplicative manner. The current data indicated that around sixty percent of the study participants had high probabilities of having two or more HRBs, whereas around 10% of the participants had high levels of all the six HRBs. This finding implies that it could be more effective for cancer prevention interventions to address clusters of multiple risk behaviors rather than just individual risk behaviors as these tend not to occur in isolation [45]. For example, while designing programs addressing smoking cessation, it could be effective to simultaneously promote vegetable and fruit consumption and activity also, or consider ways to re-engineer the environment to make certain riskier behaviours more costly and healthier behaviours easier.

Several sociodemographic markers predicted risk class membership. Our findings suggest that, for example, interventions and health promotion programs designed specifically for longer resident immigrant males of younger age would target a high-risk group who are likely to experience impact on their health in middle age [46]. Existing smoking cessation programs need to focus particularly on harder-to-reach populations with low socioeconomic status, for example, those with lower educational level and lived in the unstable conditions.

6. Limitations

This study has several limitations. First, only employees working on MTR infrastructure projects participated in this study. Those employed in housing construction and other construction fields were not included. However, the participants in this study were widely drawn from a workforce of over 5,000 involved in the territory-wide expansion of the rail system in Hong Kong, the largest infrastructure project currently in progress there. Moreover the wide scope of work involving tunneling, building stations, and elevated rail lines, and associated power and signaling work means a very broad cross-section of skills and tradespeople was captured. They are therefore likely to be highly representative of Hong Kong construction workers generally. Second, this was a cross-sectional study which does not provide opportunities to observe any changes in each class or infer causality. Longitudinal studies should be conducted to explore the growth and decay of risk behaviors in the future. Some of the assessments used were coarse and workflows did not permit more nuanced assessments, which might have provided more precise estimates. Last but not the least, we relied on self-report–based questionnaire data in this study, which could generate reporting bias. However, any biased reporting would likely have underestimated lifestyle risk prevalence among participants.

7. Conclusion

In conclusion, four different classes of cancer risk clustering were identified among a large sample of Hong Kong construction workers based on the cancer-related HRBs, of smoking, alcohol consumption, poor dietary habits, and physical inactivity. The significance of this study lies in using LCA to explore the underling clusters and the recognition of symptom clustering and sociodemographic profiling. Several sociodemographic characteristics were found to be associated with different HRB clusters, and these findings inform possible health promotion interventions that target different employee subgroups in the construction industry.

Author contributions

N. X. contributed to materials development, data entry and analysis, and also in the manuscript writing. W. L. contributed in planning and liaison, materials development, data collection, on-

site supervision, data analysis supervision, and also in the manuscript writing. P. T. contributed to materials development, on-site supervision, health education, data collection, and in data analysis. S. Y. contributed to planning, materials development, and in manuscript writing. N. Z., W. Z., and K. M contributed to materials development and data collection. R. F. contributed to the proposal and funding, planning, materials development, quality control, data analysis supervision, and manuscript writing and also served as a guarantor.

Funding

The Worker Health and Well-being Month was supported by QBE Hong Kong & Shanghai Insurance Limited.

Conflict of interest

The authors declare no competing interests.

Acknowledgments

The authors thank the MTR Corporation Limited for helping to coordinate the Worker Health and Well-being Month and the Worker Health and Well-being Month participants. The authors also thank the research team from the Division of Behavioural Sciences of the School of Public Health and the Department of Real Estate & Construction at the University of Hong Kong for their help with data collection.

Appendix A. Supplementary data

Supplementary data to this article can be found online at https://doi.org/10.1016/j.shaw.2019.12.009.

Appendix A
Types of construction trades of 1,443 participants.

Types of construction trades	Frequency (percentage)
Rebar	32 (2.2)
Shotfirer	14 (1.0)
Concreter	58 (4.0)
Rigger	54 (3.7)
Miner	39 (2.7)
Welder	61 (4.2)
Carpenter	75 (5.2)
Scaffolder	57 (4.0)
Electrical wireman	105 (7.3)
Leveler	86 (6.0)
Plasterer	3 (0.2)
Signal man	78 (5.4)
Others	778 (53.9)
Multiple work	3 (0.2)

References

[1] Legislative Council HKSAR. Updated background brief on construction manpower in Hong Kong Hong Kong; 2012.
[2] Siu P. Hong Kong facing shortage of 10,000 construction workers - and MTR is suffering; 2014.
[3] Australian Institute of Health and Welfare. Risk factors and participation in work. Canberra: Australian Institute of Health and Welfare; 2010.
[4] De Wind A, Geuskens GA, Reeuwijk KG, et al. Pathways through which health influences early retirement: a qualitative study. BMC Public Health 2013;13:292.
[5] Kolmet M, Mariño R, Plummer D. Anglo-Australian male blue-collar workers discuss gender and health issues. Int J Men's Health 2006;5:81–91.
[6] Arndt V, Rothenbacher D, Daniel U, Zschenderlein B, Schuberth S, Brenner H. Construction work and risk of occupational disability: a ten year follow up of 14,474 male workers. Occup Environ Med 2005;62:559–66.
[7] Petersen JS, Zwerling C. Comparison of health outcomes among older construction and blue-collar employees in the United States. Am J Ind Med 1998;34:280–7.
[8] Lingard H, Turner M. Improving the health of male, blue collar construction workers: a social ecological perspective. Construction Manage Econ 2015;33:18–34.
[9] Department of Health HKSAR. Health facts of Hong Kong; 2014.. http://www.dh.gov.hk/english/statistics/statistics_hs/files/Health_Statistics_pamphlet_E.pdf.
[10] Lim SS, Vos T, Flaxman AD, et al. A comparative risk assessment of burden of disease and injury attributable to 67 risk factors and risk factor clusters in 21 regions, 1990–2010: a systematic analysis for the Global Burden of Disease Study 2010. The Lancet 2013;380:2224–60.
[11] Mays D, Peshkin BN, Sharff ME, et al. Correlates of adherence to a telephone-based multiple health behavior change cancer preventive intervention for teens the healthy for life program (HELP). Health Educ Behav 2012;39:18–26.
[12] Spring B, Moller AC, Coons MJ. Multiple health behaviours: overview and implications. J Public Health 2012;34:i3–10.
[13] Reeves MJ, Rafferty AP. Healthy lifestyle characteristics among adults in the United States, 2000. Arch Intern Med 2005;165:854–7.
[14] Chou KL. The prevalence and clustering of four major lifestyle risk factors in Hong Kong Chinese older adults. J Aging Health 2008;20:788–803.
[15] Koh TY, Rowlinson S, Shen YZ. Worker health & wellbeing month 2013: a Review of some results. In: MTR 6th safety practitioners conference 2013. Hong Kong.
[16] Alavinia SM, Van Den Berg TI, Van Duivenbooden C, Elders LA, Burdorf A. Impact of work-related factors, lifestyle, and work ability on sickness absence among Dutch construction workers. Scand J Work Environ Health 2009;35:325–33.
[17] Groeneveld IF, Proper KI, van der Beek AJ, Hildebrandt VH, van Mechelen W. Factors associated with non-participation and drop-out in a lifestyle intervention for workers with an elevated risk of cardiovascular disease. Int J Behav Nutr Phys Act 2009;6:80.
[18] Bush K, Kivlahan DR, McDonell MB, Fihn SD, Bradley KA. The AUDIT alcohol consumption questions (AUDIT-C): an effective brief screening test for problem drinking. Arch Intern Med 1998;158:1789–95.
[19] Yip B, Chung RY, Chung V, et al. Is alcohol use disorder identification test (audit) or its shorter versions more useful to identify risky drinkers in a Chinese population? A diagnostic study. PloS One 2015;10 e0117721.
[20] Pereira SMP, Li L, Power C. Early-life predictors of leisure-time physical inactivity in midadulthood: findings from a prospective British birth cohort. Am J Epidemiol 2014;180:1098–108.
[21] Wang J, Wang X. Structural equation modeling: applications using Mplus. John Wiley & Sons; 2012.
[22] Jackson N, Denny S, Sheridan J, et al. Predictors of drinking patterns in adolescence: a latent class analysis. Drug Alcohol Depend 2014;135:133–9.
[23] Nylund KL, Asparouhov T, Muthén BO. Deciding on the number of classes in latent class analysis and growth mixture modeling: a Monte Carlo simulation study. Struct Equ Model 2007;14:535–69.
[24] Geiser C. Latent class analysis. In: Little T, editor. Data analysis with mplus. New York: The Guilford; 2013. p. 232–70.
[25] Lo Y, Mendell NR, Rubin DB. Testing the number of components in a normal mixture. Biometrika 2001;88:767–78.
[26] Muthén LK, Muthén BO. Mplus user's guide. 6th ed. Los Angeles, CA: Muthén & Muthén; 1998-2010.
[27] IBM SPSS statistics for windows, version 20.0 [program]. Armonk, NY: IBM Corp; 2011. Released.
[28] Census and Statistics Department HKSAR. In: Department CaS, editor. Thematic household survey report - report No. 53 2013. Hong Kong.
[29] Development Bureau HKSAR. Annual report on accident statistics and analysis for public works contracts for 2013; 2014.. http://www.devb.gov.hk/filemanager/en/content_32/2013_Annual_Report_20130630.pdf.
[30] Labour Department HKSAR. Labour department annual report; 2013.. https://www.labour.gov.hk/eng/public/iprd/2013/pdf/eng/pdf/LDT_AnnualReport2013-eng_ch4.pdf.
[31] Choudhry RM, Fang D, Ahmed SM. Safety management in construction: best practices in Hong Kong. J Prof Iss Eng Ed Pr 2008;134:20–32.
[32] Man SS, Chan AH, Wong HM. Risk-taking behaviors of Hong Kong construction workers–A thematic study. Saf Sci 2017;98:25–36.
[33] Hill D, Borland R. Adults' accounts of onset of regular smoking: influences of school, work, and other settings. Public Health Rep 1991;106:181.
[34] Berrigan D, Dodd K, Troiano RP, Krebs-Smith SM, Barbash RB. Patterns of health behavior in US adults. Prev Med 2003;36:615–23.
[35] Poortinga W. The prevalence and clustering of four major lifestyle risk factors in an English adult population. Prev Med 2007;44:124–8.
[36] Region TGoHKSA. Demographics: expectation of life at birth. The Government of Hong Kong Special Administrative Region; 2014. 2014.
[37] Cheung KSL, Yip PSF. Trends in healthy life expectancy in Hong Kong SAR 1996–2008. Eur J Ageing 2010;7:257–69.
[38] Colditz G, Atwood K, Emmons K, et al. Harvard report on cancer prevention volume 4: harvard cancer risk index. Cancer Causes Control 2000;11:477–88.
[39] Kogevinas M, Cancer IAfRo. Social inequalities and cancer. France: International Agency for Research on Cancer Lyon; 1997.

[40] Södergren M, Wang WC, Salmon J, Ball K, Crawford D, McNaughton SA. Predicting healthy lifestyle patterns among retirement age older adults in the WELL study: a latent class analysis of sex differences. Maturitas 2014;77:41–6.
[41] Fiscella K, Franks P, Gold MR, Clancy CM. Inequality in quality: addressing socioeconomic, racial, and ethnic disparities in health care. JAMA 2000;283:2579–84.
[42] Ward E, Jemal A, Cokkinides V, et al. Cancer disparities by race/ethnicity and socioeconomic status. CA Cancer J Clin 2004;54:78–93.
[43] Bauman A, Ainsworth BE, Sallis JF, et al. The descriptive epidemiology of sitting: a 20-country comparison using the International Physical Activity Questionnaire (IPAQ). Am J Prev Med 2011;41:228–35.
[44] Lee PH, Yu Y-Y, McDowell I, Leung GM, Lam T. A cluster analysis of patterns of objectively measured physical activity in Hong Kong. Public Health Nutr 2013;16:1436–44.
[45] Prochaska JJ, Spring B, Nigg CR. Multiple health behavior change research: an introduction and overview. Prev Med 2008;46:181–8.
[46] Dong XS. Health behaviors and health outcomes among construction workers in the United States, a longitudinal study. In: 142nd APHA annual meeting and exposition. APHA; 2014 (November 15-November 19, 2014).