Examining the Predictors of Cervical Screening in Newfoundland and Labrador: The Complex Interplay of its Multiple Influences

Report

June 9, 2014

Newfoundland & Labrador Centre for Health Information

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Executive Summary

Cervical cancer is the fourth most common cancer and the fourth most frequent cause of cancer-related deaths among women worldwide, with a majority of these cases found in developing nations (Ferlay et al., 2013). Incidence and mortality rates are low among developed countries, including Canada, due to initiation of effective screening programs (Anderson et al., 1988; Gustafsson et al., 1997a). In fact, screening for cervical cancer has been regarded as having a greater influence in reducing incidence and mortality than screening for any other cancer. Despite the proven efficacy of cervical screening programs, this preventive service is still under-utilized by some women. In addition, most studies fail to capture complex interrelationships between risk factors and screening outcomes. The Newfoundland and Labrador Provincial Cervical Screening Initiatives Program commissioned the Newfoundland and Labrador Centre for Health Information to undertake this study to investigate the interrelationships between various factors and their relationship with adequate participation in and retention of cervical screening in Newfoundland and Labrador. This will help identify populations that are in need of interventions to improve screening outcomes.

Using survey and administrative data, results showed that being younger, married or living common-law, having a regular doctor, having a higher socioeconomic status, and having excellent self-perceived health were associated with adequate participation in cervical screening. Being younger, having a higher socioeconomic status, having excellent self-perceived health, and having healthy lifestyle habits were also associated with adequate screening retention.

A major strength of this research was it being one of the first studies to develop a conceptual model and use latent class and mixture modeling analysis to assess associations between the complex risk factors and cervical screening outcomes. As well, the current study used administrative data that captures actual screening behaviour of a representative cohort of women eligible for cervical screening in Newfoundland and Labrador. Limitations include inconsistencies between participation and retention groups within the conceptual framework, the inability to develop and assess a latent class variable for access to healthcare, limited information on key variables such as sexual history and provider-related factors, and potential follow-up bias and information loss due to attrition.

While further research is needed to include a more comprehensive conceptual framework for cervical screening, this study identified that being older, having lower socioeconomic status, and having poor self-perceived health were associated with inadequate cervical screening participation and retention in Newfoundland and Labrador. Findings highlight the importance of reaching these high-risk women in an effort to increase uptake and retention of screening in these groups. Screening initiatives should include strategies for recruiting such under screened women.

1.0 Introduction

Globally, cervical cancer is the fourth most common cancer and the fourth most frequent cause of cancer-related deaths among women (Ferlay et al., 2013). In 2012, it was estimated that 528,000 new cases of cervical cancer were diagnosed worldwide, and that 266,000 women died from cervical cancer that same year (Ferlay et al.). The disease incidence shows clear geographical variation. Eighty-five per cent of these cases were diagnosed in developing countries, where cervical cancer accounts for approximately 12% of cancers in women (Ferlay et al.). It is the most common cancer in women in many regions, and is in fact the second most common cause of cancer-related deaths among women in developing countries (Ferlay et al.).

Incidence and mortality rates in Canada are relatively low. Among Canadian women, it is the 13th most frequently diagnosed cancer and is the 16th most common cause of cancer mortality (Canadian Cancer Statistics, 2013). Approximately 1,450 new cases of cervical cancer were estimated to have been diagnosed in Canadian women in 2013 and an estimated 380 women died from the disease that year (Canadian Cancer Statistics). The provinces with the highest incidence rates of cervical cancer are Prince Edward Island and Newfoundland and Labrador, with rates of 10 per 100,000; Newfoundland and Labrador is among the provinces with the highest mortality rate with 2 per 100,000 (Canadian Cancer Statistics).

The lower risk for cervical cancer in developed countries is a relatively recent phenomenon. This trend is attributed to effective cervical cytology screening programs. Incidence rates of invasive cervical cancer have dropped by 70% since the introduction of cytological screening in some populations (Gustafsson et al., 1997a). Before the introduction of screening programs in the 1950s and 1960s, the incidence rates in most developed countries were similar to those found in developing countries today (Anderson et al., 1988; Gustaffson et al., 1997b). In fact, screening for cervical cancer has been regarded as having a greater influence in reducing incidence and mortality than screening for any other cancer.

Despite the proven efficacy of cervical screening by cytology, maximizing the benefits of this preventive service has been hampered by under-utilization by some women. Newfoundland and Labrador has historically been among the provinces with the lowest participation rates; however, improvements have been observed in recent years (Canadian Partnership Against Cancer, 2013).

There has been extensive research investigating the socio-demographic, health system, health status and lifestyle factors associated with cervical screening in North America. Socio-demographic correlates include age, income, educational attainment, marital status, rural/urban place of residence, race/ethnicity, and immigrant status (Blackwell, Martinez, & Gentleman, 2008; Breen et al., 2001; Finkelstein, 2002; Hewitt, Devesa, & Breen, 2004; Hiatt et al., 2002; Johnston et al., 2002; Maxwell et al., 2001; Qi et al., 2006; Wang, Nie, & Upshur, 2009). Health system correlates include usual source of care, insurance coverage, and physician recommendation (Blackwell, Martinez, & Gentleman; Cardarelli, Kurian, & Pandya, 2010;

Couglin et al., 2005; Finkelstein; Hewitt et al.; Hiatt et al.; Maxwell et al.; McIsaac, Fuller-Thompson, & Talbot, 2001; Meissner et al., 2009; Qi et al.). Health status and lifestyle correlates include history of cancer, self-reported health status, disabilities or functional limitations, body mass index, smoking, and physical activity (Blackwell et al.; Cohen et al., 2008; Maxwell et al.; Meissner et al.).

There are, however, important limitations with the current cervical screening empirical literature. The majority of studies have been cross-sectional in nature. Without examining the relationship between and among factors and screening behaviour over time, temporality cannot be established, thus causality and prediction of future use is limited. Further, a limited number of studies have examined sustained screening behaviour. What influences screening as a one-time event could potentially be different from retention. In addition, most studies have used data analytic techniques that test the association between a characteristic and the screening outcome. Generally, they have not considered the complex interrelationships of these characteristics with the outcome to determine a causal pathway. Finally, the research largely uses self-reported screening data, which is subject to response bias and misclassification, as women tend to over-report their screening behaviour (Howard, Agarwal, & Lytwyn, 2009; Rauscher et al., 2008).

Given the aforementioned methodological limitations in the available research, and the fact that Newfoundland and Labrador has historically had among Canada`s lowest cervical screening rates, there was a need to examine screening utilization in this province in a way that can assess the complex interplay of its multiple influences and to predict future use. This will help identify populations that are in need of interventions to improve screening outcomes.

The objectives of the study were to investigate the interrelationships between various factors and their relationship with adequate participation in cervical screening in Newfoundland and Labrador and to investigate the interrelationships between various factors and their relationship with adequate retention of cervical screening.

2.0 Methods

2.1 Study Design and Data Sources

This study consisted of both a cross-sectional study and a retrospective cohort study using population-based administrative databases. The following data sources were linked through a multi-step data linkage process: 1) the Newfoundland and Labrador component of the Canadian Community Health Survey (2001, 2003, 2005, and 2007/08); and 2) the Newfoundland and Labrador Cervical Cancer Surveillance System (1998-2009).

The Canadian Community Health Survey (CCHS) is a large cross-sectional survey designed to assess health determinants, health status, and health systems utilization in approximately 130,000 persons residing in Canada. The CCHS targets persons 12 years or older who are living in private dwellings in any of the 10 provinces or three territories. Persons living on Indian Reserves or Crown Lands, residents of institutions, and full-time members of the Canadian Armed Forces were excluded from the survey. The CCHS uses a multi-stage stratified weighting scheme to represent 98% of the Canadian population aged 12 years or older.

The Cervical Cancer Surveillance System (CCSS) is a comprehensive longitudinal administrative database for the study of cervical cancer and cervical cancer screening in Newfoundland and Labrador. This is a composite database comprised of various administrative databases which collect information on cervical cancer, cytology screening, hospitalizations, mortality, and fee-for-service physician claims. Cervical cancer and cytology components are obtained from the Provincial Cancer Registry and Provincial Cervical Cytology Registry, provided to the Newfoundland and Labrador Centre for Health Information (NLCHI) by the Cancer Care Program. The Cancer Registry contains information on demographics, diagnosis, method of diagnosis, site, stage, morphology and behaviour of cancer, patient status, as well as treatment and provider information. The Cytology Registry collects demographic information and cytology findings for Pap smears. Information regarding hospitalizations is captured in the Clinical Database Management System, the provincial discharge abstract database containing demographic, clinical, and procedural data on all acute care and surgical day care hospitalizations in the province. Mortality data was extracted from the provincial Mortality Surveillance System, maintained by NLCHI, and is compiled from provincial death notifications surrounding each death for both resident and non-resident mortalities. The physician claims data comes from the provincial Medical Care Plan which includes information on services provided, diagnosis and physician demographics.

2.2 Study Populations and Measures

2.2.1 Cervical Screening Participation

The screening participation cohort comprised of female residents of Newfoundland and Labrador aged 20-72 at the time of the CCHS interview. The primary outcome for this component was 'adequate participation in cervical screening' and was defined as having had a Pap smear within three years prior to the CCHS interview date (subsequently defined as an index screen). Women who were not 20-69 years of age (the recommended screening age range) at time of index screen were excluded from the study. Women who were diagnosed with cervical cancer between index screen and CCHS interview date were also excluded.

2.2.2 Cervical Screening Retention

The screening retention cohort comprised of a sample of women who had a negative index screen in the screening participation cohort. The outcome for this component was 'adequate retention of cervical screening' and was defined as having been rescreened within three years of the index screen and subsequently rescreened within three-year intervals thereafter. Women were followed up to a maximum of four rescreens to determine their retention adequacy. Adequate retention excludes women who returned for re-screening at 70 years of age or older, as this falls outside of the recommended screening age range. Further, women who either died or were diagnosed with cervical cancer between their index screen and first rescreen were not included in the retention study cohort.

2.2.3 Covariate Measures

A number of factors were examined for their relationship with cervical screening. Socio-demographic, health system, health status, and lifestyle factors from the CCHS were included in the study. The same variables were used in both the participation and retention components of the study. These factors were age, education, income, marital status, urban/rural place of residence, having a regular doctor, number of consultations with a family physician, self-perceived heath status, presence of a chronic condition, sense of belonging to local community, body mass index, smoking, and physical activity participation.
Variable definitions and descriptions are as follows:

i. *Age*: Age was defined as a respondent's current age at the time of CCHS interview.

ii. *Education*: Respondents were asked about their highest level of education. Responses were categorized into four categories: 1) less than secondary school graduation, 2) secondary school graduation but no post-secondary education, 3) some post-secondary education, and 4) post-secondary degree or diploma. Due to smaller counts, responses for categories three and four were combined.

iii. *Income*: This variable grouped the total annual household income from all sources. Income classes were coded into three categories: 1) low income: less than $15,000 per year; 2) middle income: $15,000 to $49,999 per year; and 3) higher income: $50,000 or greater per year.

iv. *Marital status*: This variable indicated the current marital status of each respondent and was coded into two groups: 1) married/common-law, and 2) widowed/divorced/separated/single.

v. *Urban/rural place of residence*: Urban/rural classification is a derived variable in the CCHS that uses information based on the respondent's place of residence and whether places of residence were located within derived boundaries of census metropolitan areas or census agglomerations as defined by Statistics Canada. Based on this, respondents' place of residence was classified as urban or rural place of residence.

vi. *Regular doctor*: Respondents were asked in the CCHS interview if they have a regular doctor; responses were coded as yes, no, don't know, or refused to answer.

vii. *Number of physician consults*: Respondents were asked in the CCHS interview, "In the past 12 months, how many times have you seen, or talked on the telephone, about your physical, emotional, or mental health with a family doctor". The total numbers of consults to physicians were recorded.

viii. *Self-perceived health status*: This variable indicated the respondent's heath status based on her own judgement. Poor and fair responses were classified as a group (poor/fair); Good response was a group, and very good and excellent were grouped together (very good/excellent).

ix. *Presence of chronic condition*: This variable indicated if an individual responded as having one or more pre-defined chronic diseases diagnosed by a health professional. Responses were classified as either yes or no.

x. *Belonging to community*: Respondents were asked in the CCHS interview to describe their sense of belonging in their community. Responses were coded as either 'weak' or 'strong' sense of belonging.

xi. *Body mass index (BMI):* Respondents were asked in the CCHS interview to self-report their height and weight. BMI was derived for each respondent who reported their height and weight by dividing weight in kilograms by height in meters squared.

xii. *Smoking*: This variable indicated the current smoking status of the respondent. It was grouped into two categories: 1) daily/occasional smoker, and 2) never/former smoker.

xiii. *Physical activity*: This variable identified a respondent's physical activity index. The variable was derived from a series of questions asked to the respondent such as daily energy expenditure, frequency, number, and type of leisure time activity. Physical activity was coded into two groups, 1) active/moderate and 2) inactive.

2.3 Data Analysis

Descriptive statistics (frequencies, percentages, and means) were produced for socio-economic and socio-demographic, health and lifestyle characteristics, as well as screening outcomes. Independent t-tests and chi-square analysis were used to examine associations between screening outcomes and measured risk factors.

Latent class analysis was used to describe underlying (latent) variables that are not measured from a set of related measured variables. Three latent class variables were constructed using variables in the CCHS for the participation and retention components of the study. The three latent class variables were 1) socioeconomic status (SES), 2) lifestyle habits, and 3) access to care. The SES construct was derived using annual household income and highest attained education level variables. The lifestyle variable was derived using three measured variables: physical activity index, smoking status, and BMI. Finally, the access to care variable was derived using rural/urban status, sense of community belonging, regular doctor status, and number of consultations with a family physician within the previous year of being interviewed. In addition, the outcome variable, 'adequate retention', was constructed using information from a patient's first rescreen up to their fourth rescreen.

A conceptual framework was developed that examined the relationships of the latent class factors as well as measured risk factors to see how these factors related to adequate participation and retention (see Appendix B for further detail). The framework was then tested using latent class analysis and mixture modeling to see how well it supported the data.

2.4 Ethical Considerations

This study was approved by the Human Investigation Committee (HIC), Faculty of Medicine, Memorial University of Newfoundland. HIC is the research ethics board responsible for reviewing research on human subjects in Newfoundland and Labrador. Approval to access data was granted by the Secondary Uses Committee of the NLCHI. To ensure confidentiality and protect privacy, all direct personal identifiers were removed and non-identifiable values were assigned to unique records for data linkage and analysis purposes. Only appropriate members of the research team had access to data. All data were stored in NLCHI's Network Information Management System, a secure and private data network.

3.0 Results

3.1 Screening Participation Results

The study sample consisted of 3,674 women. All variables contained less than one percent missing data, except for family income (5.9% missing) and BMI (5.8% missing). Age at time of interview ranged between 20 and 72 with median age being 44 years (SD=13.1). Sixty-one percent of the sample (n=2,253) lived in an urban area and 70% were currently married or living common-law at the time of interview (n=2,566). Of those who reported an annual income and/or education level, 50% earned no more than $60,000-$69,999, while 25% had less than high school education.

Characteristics of the study sample by screening participation status are presented in Table 1. Approximately 76% of individuals (n=2,781) were classified as having an adequate index screen as defined by the study protocol. For adequate screeners, mean age at interview was 42.9, while mean age at interview for inadequate screeners was 47.8 ($p<0.01$). Mean BMI for adequate screeners was significantly lower than inadequate screeners (M=26.8 vs. M=27.6, respectively; $p<0.01$). Individuals in the adequate screening group had significantly higher education and household incomes compared to those in the inadequate group ($p<0.01$). Adequate screeners were also significantly more likely to be married or living common-law (71.4% vs. 65.1%; $p<0.01$), reside in an urban area (63% vs. 44%; $p<0.01$), and have a regular family doctor (89% vs. 83%, $p<0.01$). Both screening groups reported having the same average number of physician consultations (4.5 visits). A higher proportion of adequate screening participants identified having very good/excellent self-perceived health compared to inadequate screeners ($p<0.01$). In addition, a significantly higher proportion of inadequate screeners reported having a chronic condition compared to adequate screeners ($p<0.05$). There was no difference among adequate and inadequate screeners with respect to feeling a strong sense of community belonging. A significantly higher proportion of adequate screeners were non-smokers (74.8% vs. 68.7%; $p<0.01$). Adequate screeners were also more likely to be physically active compared to inadequate screeners (40.0% vs. 35.8%; $p<0.05$).

The numbers of classes were determined for the three proposed latent class variables. For SES, a three-class solution was determined to be best, with categories low, middle and high SES. A two-class solution was identified for lifestyle habits, with categories fair to good lifestyle habits and poor lifestyle habits. For the proposed access to care latent class variable, classes could not be identified. As a result, it was decided to use its measured items (regular doctor, number of physician visits, urban/rural status, and sense of belonging to community) individually instead (See Appendix C for further detail on the latent class analysis).

Table 1: Characteristics of participation cohort by screening participation status

Variable	Adequate (SD or n)*	Inadequate (SD or n)*	PV
Age	42.9 (12.6)	47.8 (13.6)	**<0.01**
BMI[1]	26.8 (5.4)	27.6 (6.1)	**<0.01**
Education			
Less than secondary	20.8 (578)	33.6 (299)	**<0.01**
Secondary	16.1 (446)	17.8 (159)	
Post-secondary	63.0 (1,750)	51.4 (433)	
Income[2]			
< $15,000	11.7 (309)	17.7 (147)	**<0.01**
$15,000-$49,999	44.9 (1,180)	53.7 (444)	
≥$50,000	55.6 (1,461)	28.6 (236)	
Marital Status			
Married/common law	71.4 (1,985)	65.1 (581)	**<0.01**
Not married	28.6 (796)	34.9 (311)	
Place of Residence			
Rural	37.0 (1,029)	56.1 (893)	**<0.01**
Urban	63.0 (1,752)	43.9 (392)	
Has regular doctor			
Yes	89.1 (2,478)	82.9 (740)	**<0.01**
No	10.9 (302)	17.1 (153)	
Mean no. of consults	4.5 (5.8)	4.5 (6.0)	0.68
Self-perceived health			
Poor/fair	8.1 (227)	15.9 (142)	**<0.01**
Good	21.1 (590)	25.8 (230)	
Very good/excellent	70.6 (1,963)	58.3 (521)	
Has chronic condition			
Yes	68.5 (1,894)	73.4 (653)	**0.01**
No	31.5 (883)	26.6 (237)	
Sense of belonging			
Weak	78.7 (2,190)	78.1 (698)	0.65
Strong	21.3 (579)	21.9 (189)	
Smoker			
Yes	25.2 (701)	31.2 (279)	**<0.01**
No	74.8 (2,080)	68.7 (614)	
Physical activity			
Active/moderate	40.0 (1,112)	35.8 (319)	**<0.05**
Inactive	60.0 (1,664)	64.1 (571)	

[1] 5.8% missing for BMI; [2] 5.9% missing for income; Adeq- adequate rescreen; Inadeq- Inadequate rescreen; PV- p-value; SD-standard deviation; n- number of cases; * SD computed for continuous variables, n computed for categorical variables; categorical variables are given as percentages; bolded p-values are statistically significant.

Table 2 provides parameter estimates and odds ratios for the screening participation mixture model. The table presents two simultaneous regression models. The first part examines the effects of SES on fair to good lifestyle habits, while the second part examines the effects of multiple measured and latent class risk factors on adequate screening participation. For the lifestyle component, those with low SES were less likely to be classified with fair to good lifestyle habits compared to high SES reference group. Likewise, those in the middle SES group were less likely to be classified with fair to good lifestyle habits compared to high SES individuals; however, these results were not significant.

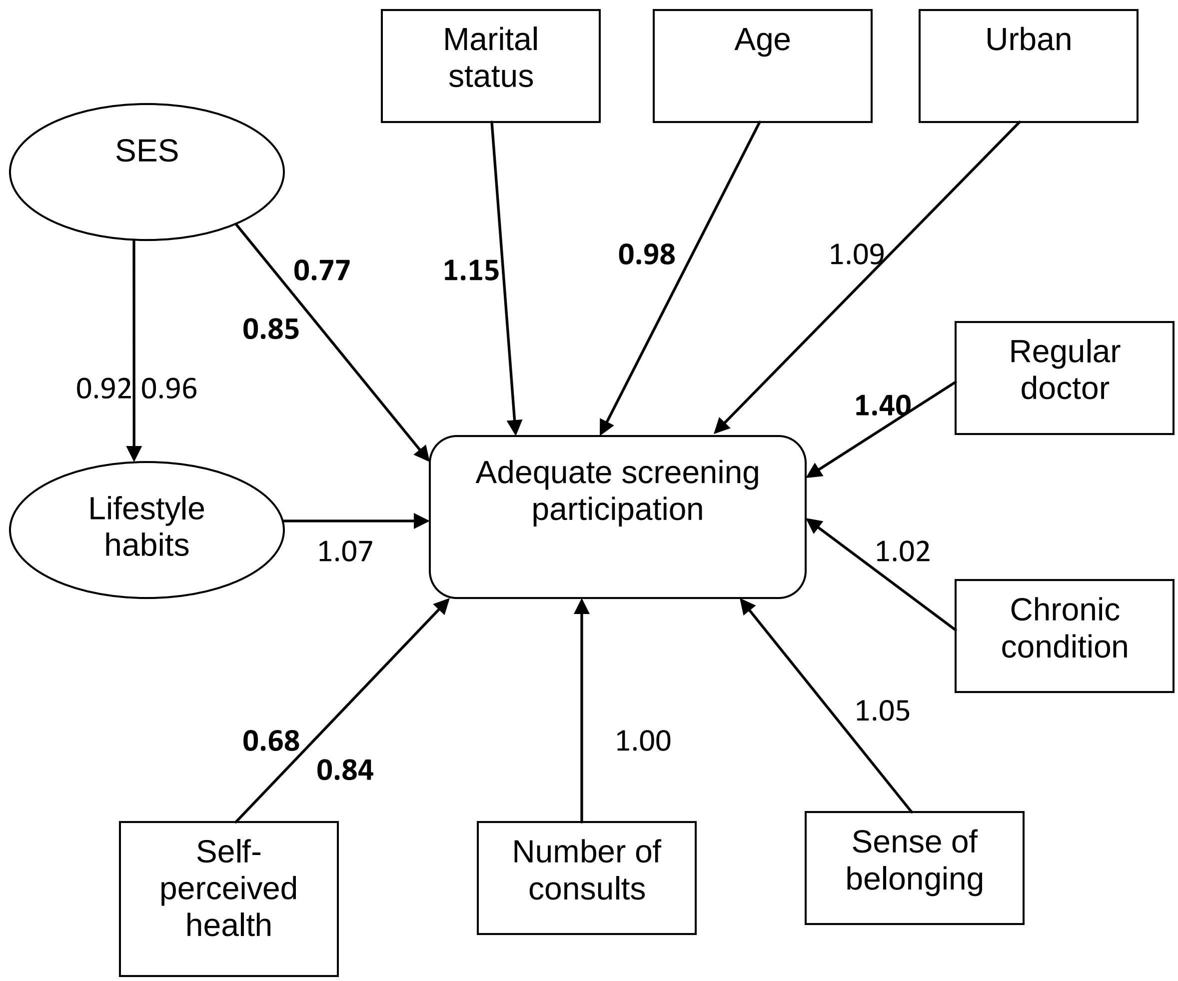
Table 2: Model estimates for screening participation mixture model

Variables	Estimate	OR	Std Err	95% CI (OR)	P-value
Good lifestyle habits on					
Low SES	-0.08	0.92	0.10	0.78-1.12	0.43
Mid SES	-0.04	0.96	0.09	0.87-1.15	0.63
Adequate participation on					
Married	**0.14**	**1.15**	**0.05**	**1.04-1.27**	**<0.01**
Age	**-0.02**	**0.98**	**0.002**	**0.97-0.98**	**<0.01**
Urban	0.09	1.09	0.05	0.99-1.21	0.07
Regular doctor	**0.34**	**1.40**	**0.07**	**1.22-1.61**	**<0.01**
Chronic Condition	0.02	1.02	0.07	0.89-1.17	0.66
Number of consults	0.003	1.00	0.004	0.99-1.01	0.49
Sense of belonging	0.05	1.05	0.06	0.94-1.18	0.36
Low SES	**-0.26**	**0.77**	**0.07**	**0.67-0.88**	**<0.01**
Mid SES	**-0.16**	**0.85**	**0.06**	**0.61-0.96**	**<0.01**
Good lifestyle habits	0.07	1.07	0.05	0.97-1.18	0.12
Poor/fair perceived health	**-0.38**	**0.68**	**0.08**	**0.58-0.80**	**<0.01**
Good perceived health	**-0.17**	**0.84**	**0.05**	**0.76-0.93**	**<0.01**

OR- odds ratio; Std Err – standard error; CI – confidence interval; SES – socioeconomic status; significant effects (p<0.05) are bolded.

Figure 1 links mixtures model results and potential causal pathways with the modified conceptual framework for screening participation outcomes. Examining the screening participation component, those who were married or living common-law and those that had a regular doctor were significantly more likely to be adequately screened. As an individual aged by one year, she was significantly less likely to be adequately screened. Compared to women in the high SES class, those with low and middle SES were significantly associated with decreased odds of having adequate screening. Likewise, compared to women reporting excellent health, those reporting poor to fair and good health were significantly less likely to have adequate screening. All other risk factors yielded non-significant results for screening participation status.

Figure 1: Modified conceptual model linking measured and latent class risk factors to cervical cancer screening participation



Values represent odds ratios of risk factors associated with cervical screening participation; bolded values are significant associations.

3.2 Screening Retention Results

Table 3 displays characteristics of the retention cohort by screening retention status. The overall study sample consisted of 2,437 women. All covariates contained no more than 1% missing data, except for family income (5.4% missing) and BMI (5.7% missing). There were 0%, 12.9% (n=314), 23.2% (n=565), and 32.1% (n=782) data missing for the first rescreen up to the fourth rescreen, respectively. This was due, in part, to individuals becoming ineligible over time and information loss due to follow-up.

Mean age across rescreens for the adequate retention group ranged from 40.0 to 41.7 years, while mean age for the inadequate group varied from 44.7 to 45.6 years (Table 3). The adequate group was significantly younger than the inadequate group for all four rescreens. Mean BMI ranged from 26.2 to 26.5 for adequate rescreeners, while BMI ranged from 27.1 to 27.3 for inadequate rescreeners. BMI for the adequate screening group was significantly lower than the inadequate group, for all rescreens. The adequate screening retention group had a significantly higher education level and household income compared to the inadequate retention group; this trend was consistent across all four rescreens. Compared to the inadequate rescreening group, a higher proportion of adequate rescreeners lived in an urban area, the only exception being the fourth rescreen. Self-perceived health status was better for adequate rescreeners; this trend was consistent across all rescreens. A higher proportion of inadequate rescreeners had a chronic condition. This proportion was significantly higher in all but one rescreen (rescreen 3).

The numbers of classes were determined for the four proposed latent class variables. For SES, a three-class solution was determined to be best, with categories low, middle and high SES. A two-class solution was identified for lifestyle habits, with categories fair to good lifestyle habits and poor lifestyle habits. Similar to the participation cohort, for the proposed access to care latent class variable, classes could not be identified. As a result, it was decided to use its measured items (regular doctor, number of physician visits, urban/rural status, and sense of belonging to community) individually instead. For the retention outcome latent variable, a two-class solution was identified, with categories high and low screening retention (See Appendix D for further detail on the latent class analysis).

Table 3: Characteristics of retention cohort by rescreening status

Variable	Rescreen 1 (n=2,437)		PV	Rescreen 2 (n=2,123)		PV	Rescreen 3 (n=1,872)		PV	Rescreen 4 (n=1,655)		PV
	Adeq (SD or n)§	Inadeq (SD or n)§		Adeq (SD or n)§	Inadeq (SD or n)§		Adeq (SD or n)§	Inadeq (SD or n)§		Adeq (SD or n)§	Inadeq (SD or n)§	
Mean Age	41.7	45.6	**<0.01**	41.2 (12.3)	45.1 (12.7)	**<0.01**	40.1 (11.8)	44.9 (12.8)	**<0.01**	40.0 (11.3)	44.7 (12.9)	**<0.01**
Mean BMI[1]	26.5	27.2	**0.01**	26.3 (5.1)	27.3 (5.8)	**<0.01**	26.2 (4.9)	27.2 (5.7)	**<0.01**	26.2 (4.8)	27.1 (5.7)	**<0.01**
Education												
Less than secondary	17.8 (305)	29.6 (213)	**<0.01**	16.5 (204)	30.2 (267)	**<0.01**	15.7 (145)	29.6 (281)	**<0.01**	15.5 (104)	29.2 (287)	**<0.01**
Secondary	15.8 (270)	16.8 (122)		15.6 (193)	16.6 (147)		15.3 (141)	16.8 (160)		15.9 (107)	17.0 (167)	
Post-secondary	66.4 (1,135)	53.9 (392)		68.0 (843)	53.1 (469)		69.0 (636)	53.6 (509)		68.6 (461)	53.8 (529)	
Income[2]												
< $15,000	10.8 (176)	15.4 (105)	**<0.01**	9.9 (116)	17.8 (142)	**<0.01**	10.2 (89)	16.6 (149)	**<0.01**	10.4 (66)	16.5 (153)	**<0.01**
$15,000-$49,999	44.5 (722)	49.9 (339)		45.0 (530)	49.0 (407)		44.3 (386)	48.9 (439)		42.4 (269)	49.1 (457)	
≥ $50,000	44.7 (725)	34.7 (236)		45.1 (531)	33.9 (282)		45.5 (396)	34.4 (309)		47.2 (300)	34.4 (320)	
Marital Status												
Married/common law	71.4 (1,221)	71.3 (519)	0.99	27.0 (335)	29.9 (264)	0.14	73.9 (681)	70.5 (670)	0.11	74.1 (498)	71.3 (701)	0.21
Not married/widowed	28.6 (489)	28.7 (208)		73.0 (905)	70.1 (619)		26.1 (241)	29.5 (280)		25.9 (174)	28.7 (282)	
Place of Residence												
Rural	35.1 (600)	41.0 (298)	**0.01**	33.6 (417)	40.4 (357)	**<0.01**	31.9 (294)	39.8 (378)	**<0.01**	67.6 (454)	60.3 (593)	**0.01**
Urban	64.9 (1,110)	59.0 (429)		66.4 (823)	59.6 (526)		68.1 (628)	60.2 (572)		32.4 (218)	39.7 (390)	
Has regular doctor												
Yes	90.0 (1,539)	87.1 (633)	**0.04**	89.7 (1,112)	88.0 (777)	0.25	90.3 (833)	88.2 (838)	0.21	89.7 (603)	88.4 (869)	0.52
No	10.0 (171)	12.9 (93)		10.3 (233)	11.9 (105)		9.7 (89)	11.7 (111)		10.3 (69)	11.6 (113)	
Mean no. of consults	4.4 (5.5)	4.8 (6.9)	0.20	4.5 (5.2)	4.7 (6.6)	0.32	4.6 (5.4)	4.6 (6.5)	0.96	4.7 (5.5)	4.6 (6.4)	0.61
Self-perceived health												
Poor/fair	6.3 (108)	12.7 (97)	**<0.01**	6.1 (76)	12.0 (106)	**<0.01**	6.0 (55)	11.7 (111)	**<0.01**	5.2 (35)	11.7 (115)	**<0.01**
Good	21.4 (366)	19.5 (142)		20.8 (258)	173 (19.6)		20.1 (185)	19.4 (184)		18.6 (125)	19.4 (191)	
Very good/excellent	72.3 (1,235)	67.7 (492)		73.0 (905)	68.4 (604)		74.0 (682)	68.9 (655)		76.2 (512)	68.9 (677)	
Has chronic condition												
Yes	67.4 (1,150)	75.4 (548)	**<0.01**	68.9 (854)	73.3 (647)	**0.03**	69.0 (636)	72.9 (693)	0.07	68.2 (457)	72.8 (715)	**0.04**
No	32.6 (556)	24.6 (179)		30.8 (382)	26.7 (236)		30.7 (283)	26.9 (256)		31.8 (213)	27.2 (267)	
Sense of belonging												
Weak	21.2 (355)	20.1 143)	0.80	21.7 (269)	19.4 (171)	0.30	22.0 (202)	19.2 (182)	0.15	22.4 (150)	19.4 (190)	0.15
Strong	78.8 (1,347)	79.9 (581)		77.7 (964)	80.3 (709)		78.0 (718)	80.8 (764)		77.6 (521)	80.6 (789)	
Smoker												
Yes	23.4 (401)	28.9 (517)	**0.01**	23.2 (288)	28.0 (247)	**0.01**	23.5 (217)	27.7 (263)	**0.04**	23.5 (158)	27.9 (274)	0.05
No	76.5 (1,309)	71.1 (210)		76.8 (952)	72.0 (636)		76.5 (705)	72.3 (687)		76.5 (514)	72.1 (709)	
Physical activity												
Active/moderate	40.9 (699)	38.1 (276)	0.29	41.7 (517)	37.1 (328)	0.08	41.5 (383)	37.9 (359)	0.10	41.2 (277)	38.1 (374)	0.21
Inactive	59.1 (1,009)	61.9 (449)		58.2 (722)	62.6 (553)		58.5 (539)	62.1 (589)		58.8 (395)	61.9 (607)	

[1] 5.7% missing for BMI; [2] 5.4% missing for income; Adeq- adequate rescreen; Inadeq- Inadequate rescreen; PV- p-value; SD- standard deviation; n- number of cases; § SD computed for continuous variables, n computed for categorical variables; categorical variables are given as percentages; bolded p-values are statistically significant.

Table 4 displays parameter estimates and odds ratios for the screening retention mixture model. Similar to the screening participation model, this model contains two components: a regression outlining the effects of SES on lifestyle habits, followed by another regression analysis examining the effects of multiple measured and latent class risk factors on adequate screening retention. SES odds ratios were not significant for the lifestyle habits regression component.

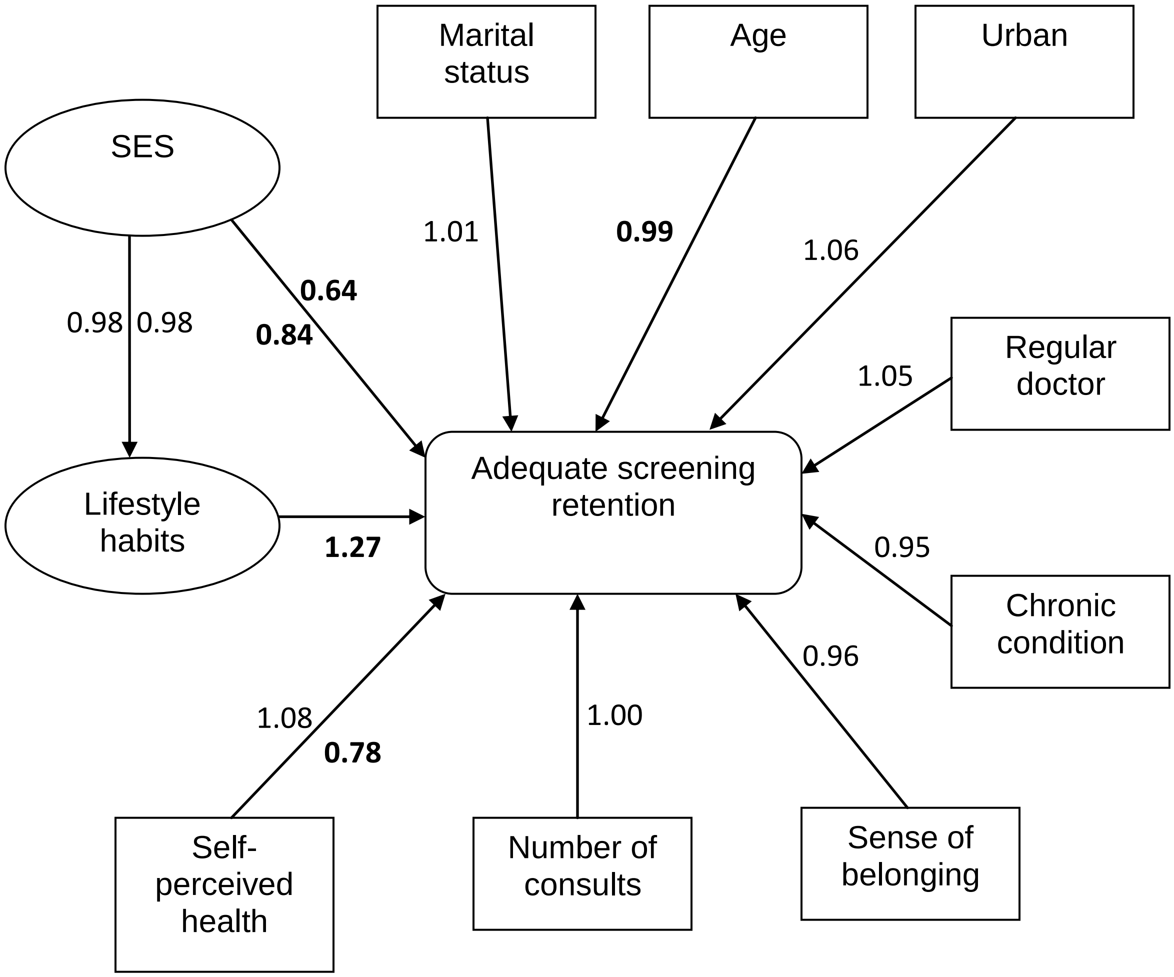
Figure 2 links the mixture model results and potential causal pathways with the modified conceptual framework for screening retention outcomes. In examining the screening retention component, as an individual aged by one year she was less likely to be adequately rescreened (OR=0.99, p<0.01). Individuals with low SES were less likely to rescreen compared to those with high SES (OR=0.64, p<0.01). Similarly, those with mid SES were less likely to be rescreened compared to those with high SES (OR=0.87, p<0.01). Women with fair to good lifestyle habits were more likely to be rescreened than those with poor lifestyle habits (OR=1.27, p<0.05). Women with poor/fair perceived health were less likely to be rescreened compared to women with excellent perceived health (OR=0.78, p<0.05). All other risk factors yielded non-significant results for screening retention status.

Table 4: Model estimates for screening retention mixture model

Variables	**Estimate**	**OR**	**Std Err**	**95% CI (OR)**	**P-value**
Good lifestyle habits on					
Low SES	-0.02	0.98	0.02	0.94-1.02	0.13
Mid SES	-0.02	0.98	0.01	0.96-1.01	0.22
Adequate retention on					
Married	0.01	1.01	0.06	0.88-1.13	0.86
Age	**-0.01**	**0.99**	**0.002**	**0.98-0.99**	**<0.01**
Urban	0.06	1.06	0.06	0.95-1.19	0.27
Regular doctor	0.05	1.05	0.09	0.80-1.25	0.59
Chronic Condition	-0.05	0.95	0.06	0.85-1.06	0.46
Number of consults	0.001	1.00	0.18	0.70-1.42	0.86
Sense of belonging	-0.04	0.96	0.08	0.89-1.12	0.57
Low SES	**-0.45**	**0.64**	**0.08**	**0.55-0.74**	**<0.01**
Mid SES	**-0.12**	**0.87**	**0.06**	**0.78-0.99**	**0.04**
Good lifestyle habits	**0.24**	**1.27**	**0.10**	**1.04-1.55**	**0.02**
Poor/fair perceived health	**-0.24**	**0.78**	**0.10**	**0.65-0.96**	**0.02**
Good perceived health	0.08	1.08	0.07	0.94-1.24	0.25

OR- odds ratio; Std Err – standard error; CI – confidence interval; SES – socioeconomic status; significant effects (p<0.05) are bolded.

Figure 2: Modified conceptual model linking measured and latent class risk factors to cervical cancer screening retention



Values represent odds ratios of risk factors associated with cervical screening retention; bolded values are significant associations.

4.0 Discussion

This study examined the complexities and interrelationships of risk factors associated with cervical screening participation and screening retention in a cohort of women in Newfoundland and Labrador from 2001-2008. Findings from the report identified factors such as younger age, being married or living common-law, having a regular doctor, higher SES, and excellent self-perceived health status as being significant predictors of adequate screening participation. These results were consistent with a previous study that examined risk factors associated with mammography screening in Newfoundland and Labrador (Dowden & Halfyard, 2012). Being younger, improved lifestyle habits, having a higher SES, and having an excellent self-perceived health status were also significant predictors of adequate screening retention.

Previous studies have also found that socioeconomic and demographic indicators such being married or living common-law and higher levels of SES were associated with improved adherence and compliance for cervical screening outcomes (Blackwell, Martinez, & Gentlemam, 2008; Wang, Nie, & Upshur, 2009). Healthcare utilization factors such as seeking regular medical care have been found to be strong predictors of screening outcomes (Finkelstein, 2002; Meissner et al., 2009). The current study also found that improved lifestyle habits (e.g. physical activity, lower BMI, and smoking cessation) positively influenced screening outcomes, which is also consistent with findings from previous research (Hiatt et al., 2002).

Results from this study indicate that complex risk factors such as SES play an important role in improving screening outcomes. Results suggested an apparent gradient effect between SES and screening outcomes; as the level of SES decreased, so did the likelihood of participation and retention of cervical screening. These results are supported by previous research (CTFPHC, 2013; Lee et al., 2013). The findings add to the growing evidence on the importance of assessing SES in cervical cancer screening and outline the importance to improve preventive services for higher risk groups in the Newfoundland and Labrador population.

Identifying barriers and inequalities is paramount for reducing disparities and developing effective screening programs (AHRQ, 2012; Daley et al., 2011; Studts et al., 2013). This study models a number of complex factors (e.g. SES, lifestyle, and access to care) to help identify primary barriers and inequalities in cervical screening. Results from this study can be used to identify priority areas and develop strategies to improve the overall delivery of cervical screening programs.

The study contained a number of strengths and limitations. A major strength of this study is that it examined factors associated with cervical screening outcomes using a latent class and mixture model analysis. This is a relatively new analytic technique for assessing associations between complex factors such as SES and lifestyle habits on screening outcomes. As such, this study is the first to identify underlying latent class structures associated with cervical screening outcomes in a representative cohort of women in Newfoundland and Labrador.

Most research in this field largely uses self-reported screening data (Howard et al., 2009; Rausher et al., 2008), which is subject to misclassification and response bias, as women tend to over-report screening. This study overcomes this limitation by using large comprehensive administrative databases that capture actual screening behaviour in the population. Cervical screening was captured by the Cervical Cancer Surveillance System; a composite administrative database set up solely for the collection and surveillance of cervical screening practices in Newfoundland and Labrador. Therefore, screening information did not rely on self-reporting; this method better reflects screening participation and retention in the province.

A further strength of this study is the development of a conceptual model to assess cervical screening utilization. Conceptual models are important in disease prevention research and health promotion as they provide a basis for comprehensive, evidence-based public health policy initiatives (Marrett et al., 2002; Winawer SJ et al., 2011). This research highlights the importance of developing a theoretical framework to aid in improving surveillance and health care delivery for a high-risk population. Further, the theoretical framework developed here was also used on breast screening participation and retention outcomes for women in Newfoundland and Labrador (Dowden & Halfyard). The results from the previous study are very similar to those found here, which provides further support of this model being a unified theoretical framework for screening initiatives in the province.

There were, however, some inconsistencies with the conceptual model. While most variables showed a relatively good fit for either screening cohort, some variables hypothesized to fit for both cohorts (e.g. lifestyle habits) did not fit. A plausible explanation for these inconsistencies could be due to the differing population characteristics between both groups. Only those with an adequate index screen were included in the retention cohort; thus, retention consisted of only those with adequate participation. This, in turn, could cause the retention cohort to initially be more compliant and hence be a healthier cohort. Due to this phenomenon, characteristics and risk factors could differ substantially between both groups. This work highlights the need to identify additional risk factors associated with retention and participation and build these components into a more overarching conceptual framework. Information was not available on sexual history and provider-related factors, such as gender that may also influence screening. Further research should use these key variables to further explore cervical screening in the province.

Another issue encountered was the inability to develop a latent class variable for access to care. Access to primary care has been previously identified as an important factor in improving screening outcomes (Mandelblatt, 1999). However, this issue is primarily data driven. For the screening participation cohort, the access to care variables for the number of physician consults and sense of belonging were not significant between adequacy groups. For the retention component, most access to care variables were not significant. This apparent between-group homogeneity could be a factor as to why adequate latent class classes could not be produced for access to care; hence, the complexity of this variable was not fully captured by the conceptual model. Although recent studies have utilized latent class analysis to examine the multi-dimensional behaviour of access to care (Thorpe et al., 2011; Jiang & Zack, 2011), very little research has examined this concept within the cervical screening realm. Further research is needed to identify a comprehensive set of measured risk variables associated with access to care to better understand its latent complexities.

Finally, it is important to note that for the retention component, some rescreening information was incomplete due to follow-up loss and ineligibility status. The retention component used rescreening information to produce a two-class latent class solution for retention status. Due to the incompleteness of the data this could have caused misclassification of individuals and potentially bias results. Latent class analysis implements a full information maximum likelihood estimator which has been shown to produce unbiased estimates if data were missing at random (Graham, 2003). However, it was beyond the scope of this research to examine misclassification error to determine the degree in which data was missing at random; therefore, misclassification bias cannot be completely ruled out in this study.

4.1 Conclusion

This study used latent class and mixture modeling approaches to assess complex risk factors associated with cervical screening outcomes. Results showed that being older, having lower SES, and having poor self-perceived health were associated with both inadequate cervical screening participation and retention. Being single and not having a regular doctor were also associated with inadequate screening participation, whereas poor lifestyle habits were associated with inadequate screening retention. While further research is needed to include a more comprehensive conceptual framework for cervical screening, these findings highlight the importance of reaching these high-risk women in an effort to increase uptake and retention of screening in these groups. Screening initiatives should include strategies for recruiting such under screened groups.

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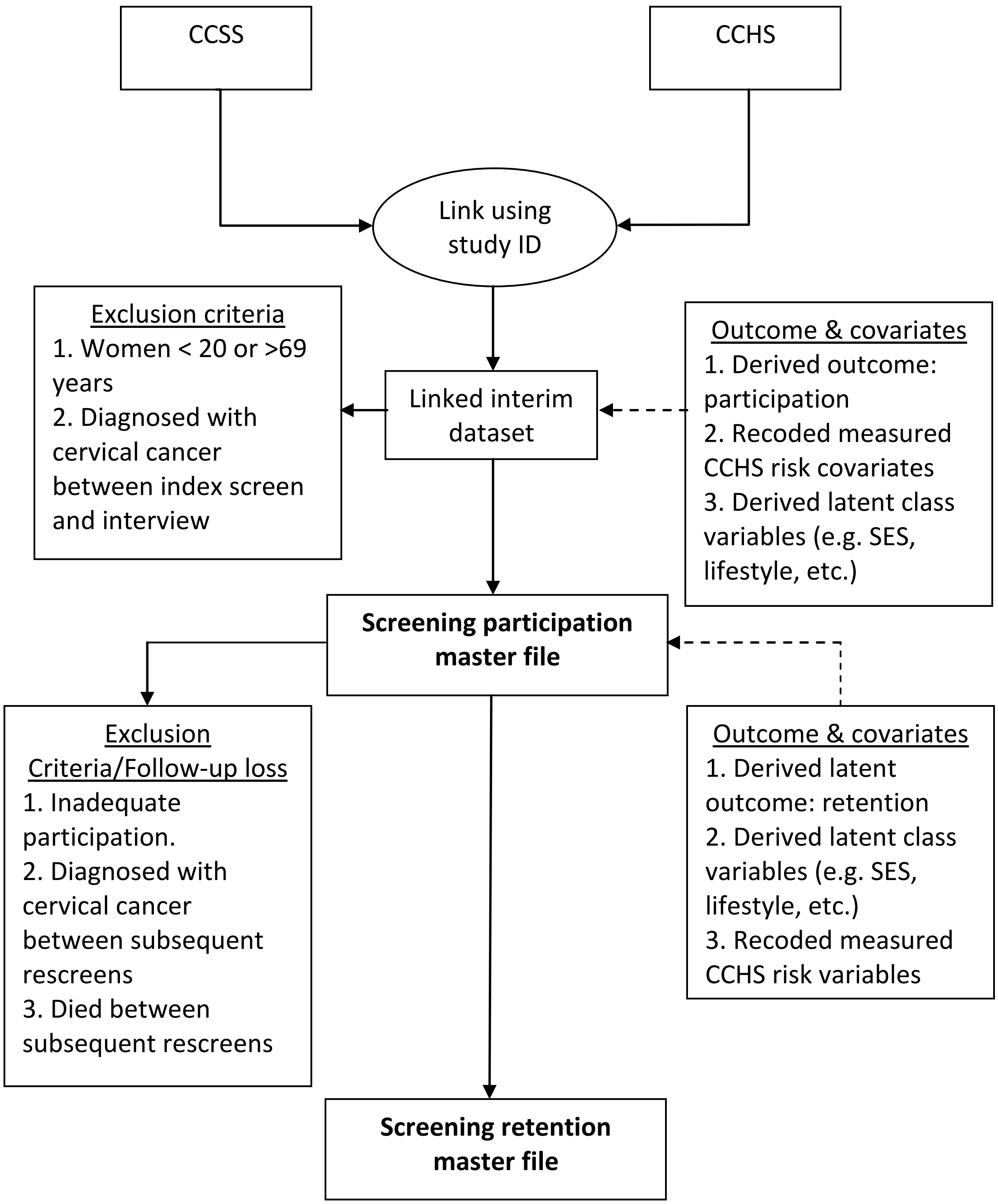
Appendix A: Database Linkage and Development Process Chart

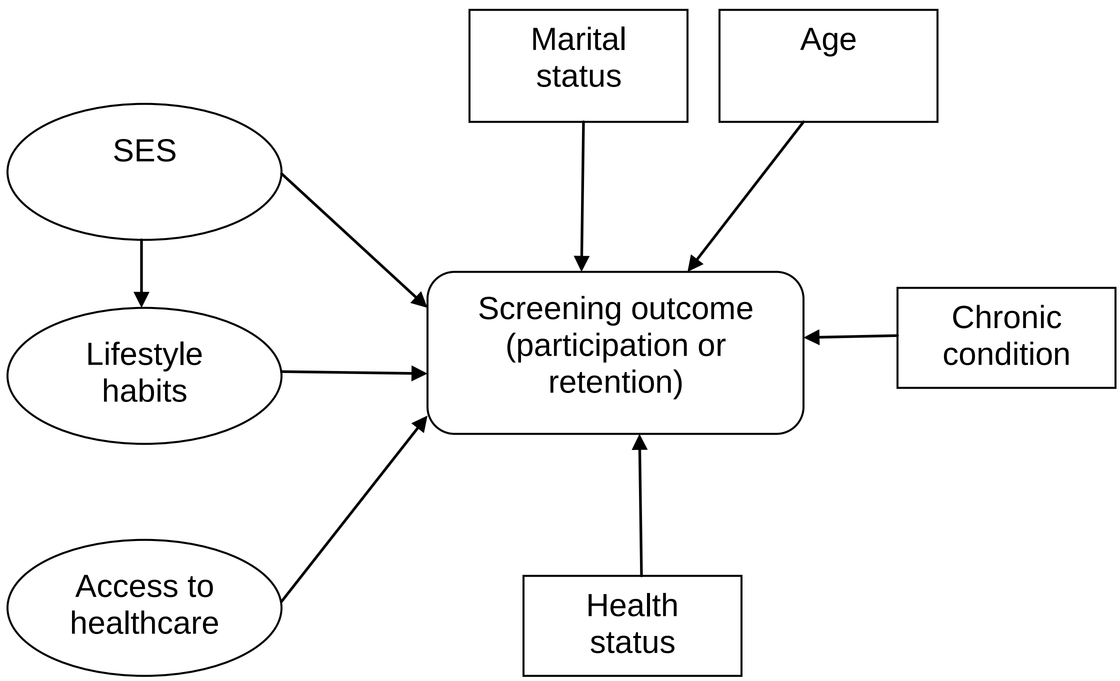
Figure A-1: Database linkage and development process chart



Appendix B: Conceptual Framework for Identifying Cervical Cancer Screening Participation and Retention

Figure B-1 outlines the basic conceptual framework used to examine interrelationships between latent class variables and individual risk factors on cervical cancer screening outcomes. The oval shaped variables represent the categorical latent class variables derived from observed measures in the data, the rectangular shaped boxes represent observed measured variables, and the curved box represents the screening outcome (either measured or latent-class). Single direction arrows represent the influence (i.e. associations) between variables; that is, the arrow pointing from one variable to another represents the potential effect of class membership of a predicting variable (source) on class membership of an outcome variable (destination). For example, focusing on the relationship between SES and screening outcome, this is interpreted as the effect of how specific SES classes (e.g. high, medium, or low) influence classification of adequate (or inadequate) screening in the study population. Note that the lifestyle latent variable is both a source and destination variable. SES classes are proposed to influence class membership of lifestyle factors which, in turn, influence class membership of adequate screening. This is an indirect relationship between SES and adequate screening. Alternatively, lifestyle classes can directly (and simultaneously) influence screening classification. This further illustrates how latent class mixture modeling provides a basis to model potential complex pathways between predictors and outcomes and aid in explaining complex intricacies in the data.

Figure B-1: Conceptual model for identifying cervical cancer screening participation and retention



Appendix C: Latent Class Analysis Results, Screening Participation

Tables C-1, C-2, and C-3 present the fit indices for hypothesized models of latent class variable in the screening participation cohort. For SES (Table C-1), a three-class solution provided the most appropriate model as its likelihood was the smallest of all models. Although aBIC was smaller compared to a two-class model, its entropy was the higher (E=0.97). However, the decision was not clear-cut, as VLMR and BLRT were significant for a two-, three-, and four-class model.

A two-class model was identified as being the best solution for the lifestyle habits latent-class (Table C-2). Likelihood values were smallest while aBIC and entropy values were largest for the two-class model compared to all other latent-class models. The VLMR and BLRT were not significant for a three-class model indicating this model did not provide a better fit than a two-class model.

Table C-3 presents model fit indices for the access to healthcare latent class variable. The analysis gave artificial results for model fits for three-, four-, and five-class models. Further, these models produced unreliable results due to model non-identification. As well, VLMR and BLRT statistics for a two-class model were non-significant meaning that a two-class latent variable did not provide any added value to the model than its measured variables. Due to spurious and non-significant results, it was decided that the access to care would be dropped from the screening participation conceptual model and its measured items: regular doctor, number of physician visits, chronic conditions, and place of residence were added as direct independent variables instead.

Table C-1: Fit indices for latent class analysis of socioeconomic status items, screening participation

Model: SES	Class 2	Class 3	Class 4	Class 5
Free Parms	9	14	19	24
Likelihood	-6,852.5	-6,597.3	-6,851.4	-6,581.4
aBIC	13,750.3	13,265.6	12,200.2	13,283.4
Entropy	0.95	0.97	0.84	0.92
VLMR (p)	3,040.3 (<0.01)	510.4 (<0.01)	31.7 (<0.01)	0.1 (0.5)
BLRT (p)	2,968.8 (<0.01)	498.2 (<0.01)	30.9 (<0.01)	0.15 (0.5)

aBIC= adjusted Bayesian information criteria; VLMR = Vuong-Lo-Mendell-Rubin fit statistic; BLRT= bootstrap likelihood ratio test

Table C-2: Fit indices for latent class analysis of lifestyle habits items, screening participation

Model: Lifestyle habits	Class 2	Class 3	Class 4	Class 5
Free Parms	8	12	16	--
Likelihood	-15,202.4	-15,123.1	-15,079.6	--
aBIC	30,445.1	30,306.6	30,239.8	--
Entropy	0.89	0.78	0.79	--
VLMR (p)	506.4 (<0.01)	158.6 (0.06)	86.9 (<0.01)	--
BLRT (p)	491.5 (<0.01)	153.9 (0.06)	84.4 (<0.01)	--

aBIC = adjusted Bayesian information criteria; VLMR = Vuong-Lo-Mendell-Rubin fit statistic; BLRT = bootstrap likelihood ratio test; -- analysis not run.

Table C-3: Fit indices for latent class analysis of access to healthcare items, screening participation

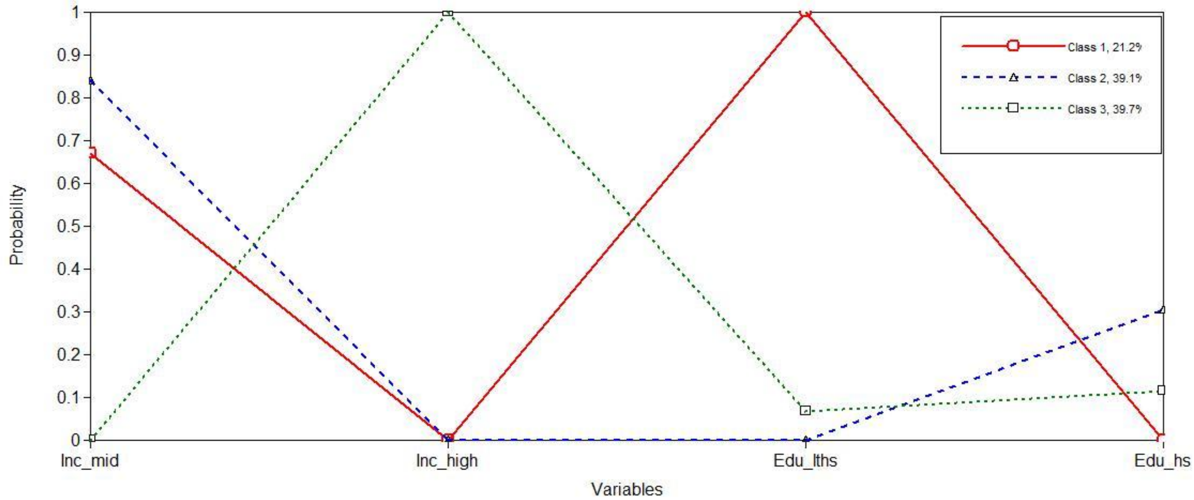
Model: Access to healthcare	Class 2	Class 3*	Class 4*	Class 5*
Free Parms	10	15	20	25
Likelihood	-16,742.0	-16,133.8	-15,734.6	-15,350.4
aBIC	33,543.2	32,343.2	31,569.9	30,826.5
Entropy	0.99	0.99	0.97	0.98
VLMR (p)	1,374.4 (0.67)	1,216.2 (<0.01)	798.4 (0.15)	768.4 (0.07)
BLRT (p)	1,295.5 (0.67)	1,146.3 (<0.01)	752.6 (0.17)	724.2 (0.09)

aBIC = adjusted Bayesian information criteria; VLMR = Vuong-Lo-Mendell-Rubin fit statistic; BLRT = bootstrap likelihood ratio test; -- analysis not run; * unreliable results due to model non-convergence

The three-class latent profile plot for SES is shown in Figure C-1. Class one contained 784 (21%) individuals, class two contained 1,394 (38%) individuals, and class three contained 1,496 (41%) individuals. For class one, the probability of endorsing mid household income was 67% while the probably of endorsing high household income was 0%. The probably of endorsing less than high school education was 100%; this class was characterized as low SES. For class two, the probability of endorsing mid income was 84%. Additionally, this group had 0% chance of endorsing high income. There was 0% probability of endorsing less than high school education and 30% probability of endorsing high school education; this class was classified as middle SES. For class three, the probability for endorsed high household income was 100% while the probability of endorsing high school or less was approximately 18%; this class was classified as high SES.

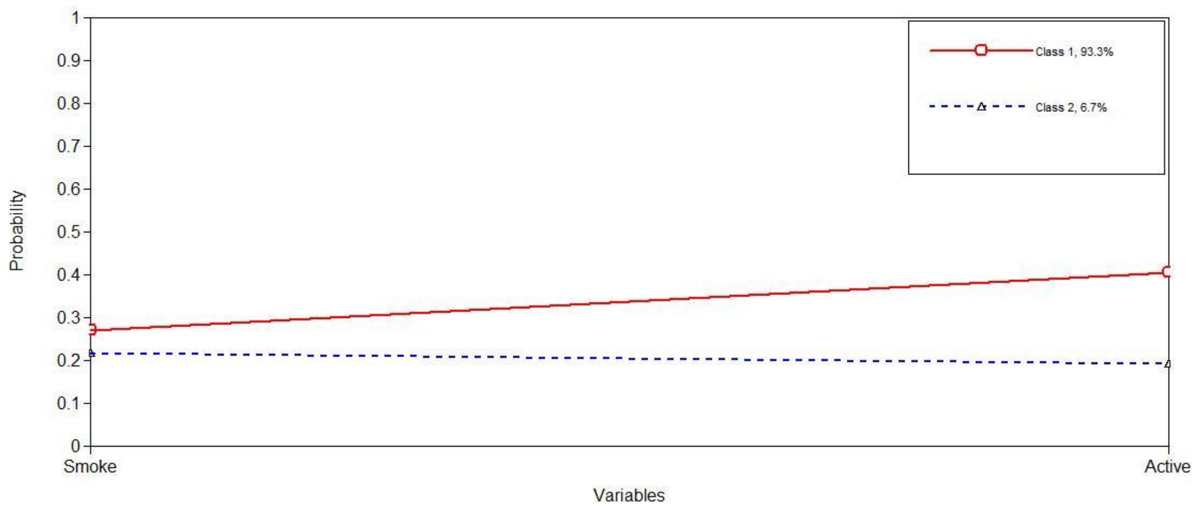
Figure C-2 contains a two-class latent profile plot for lifestyle habits. Class one contained 3,479 individuals (93%) and class two contained 195 individuals (7%). For class one, mean BMI was 26.0 (SD=4.4; results not shown) and the probability of endorsing smoking was approximately 27%, while 40% endorsed physical activity. This class was identified as having fair to good lifestyle habits. For class two, mean BMI was 40.0 (SD=4.3; results not shown) and approximately 22% endorsed smoking while only 19% endorsed physical activity. Based on these characteristics, this class was identified as having poor lifestyle habits.

Figure C-1: Latent profile plot of socioeconomic status latent variable, screening participation cohort



Inc_mid = middle household income; Inc_high = high household income; Edu_lths= less than high school education; Edu_hs = completed high school.

Figure C-2: Latent profile plot of lifestyle habits latent variable, screening participation cohort



Smoke = smoker; Active = physically active.

Appendix D: Latent Class Analysis Results, Screening Retention

Tables D-1 to D-4 present fit indices for hypothesized models of latent class variables for the retention cohort. A three-class solution provided an overall best fit for SES (Table D-1). Likelihood, aBIC, and entropy values were optimal. However, similar to screening participation cohort, the choice was not clear as the two-class model had a smaller likelihood (4,441 vs. -4,290) while VLMR and BLRT statistics were significant for a four-class model as well.

A two-class model was identified as the most optimal solution for the lifestyle habits latent variable (Table D-2). Adjusted BIC and entropy were the largest compared to all other latent class models (aBIC=22,801.7; E=0.86). The VLMR and BLRT were not significant for a three-class model which indicated it did not provide a better fit than its two-class precursor. VLMR and BLRT statistics were significant for a four-class model, but all other fit statistics indicated a poorer overall fit.

Table D-3 presents model fit indices for the access to care latent class variable. The model converged for the two-, three-, and four-class models. However, fit statistics were poor for all models indicating a latent class variable does not improve on directly measured variables. Similar to the participation cohort, access to care was dropped from the conceptual model and its measured items: regular doctor, number of physician visits, urban/rural status, and sense of belonging to community were added as direct independent variables.

Table D-4 shows model fits for the retention outcome latent variable. Likelihood and aBIC values were very similar for the two-, three-, and four-class models. Entropy was highest for the two-class model (E=0.91). VLMR and BLRT statistics were not significant for a four-class model (VLMR=0.0, p=1.0; BLRT=0.0, p=1.0). Fit indices were significant for a three-class model; however, due to non-convergence these results were unreliable. Therefore, a two-class model was deemed most appropriate.

Table D-1: Fit indices for latent class analysis of socioeconomic status items, screening retention

Model: SES	Class 2	Class 3	Class 4	Class 5
Free Parms	9	14	19	--
Likelihood	-4,441.2	-4,290.3	-4,277.1	--
aBIC	8,924.1	8,645.3	8,462.0	--
Entropy	0.95	0.97	0.91	--
VLMR (p)	2,090.7 (<0.01)	301.9 (<0.01)	26.4 (0.01)	--
BLRT (p)	2,038.4 (<0.01)	294.3 (<0.01)	25.8 (0.01)	--

aBIC = adjusted Bayesian information criteria; VLMR = Vuong-Lo-Mendell-Rubin fit statistic; BLRT = bootstrap likelihood ratio test; -- analysis not ran.

Table D-2: Fit indices for latent class analysis of lifestyle habits items, screening retention

Model: Lifestyle habits	Class 2	Class 3	Class 4	Class 5
Free Parms	8	12	16	--
Likelihood	-11,381.9	-11,325.9	-11,285.6	--
aBIC	22,801.7	22,708.7	22,647.2	--
Entropy	0.86	0.80	0.80	--
VLMR (p)	382.0 (<0.01)	112.0 (0.20)	80.5 (<0.01)	--
BLRT (p)	366.9 (<0.01)	108.4 (0.21)	78.1 (<0.01)	--

aBIC = adjusted Bayesian information criteria; VLMR = Vuong-Lo-Mendell-Rubin fit statistic; BLRT = bootstrap likelihood ratio test; -- analysis not run.

Table D-3: Fit indices for latent class analysis of access to healthcare items, screening retention

Model: Lifestyle habits	Class 2	Class 3	Class 4	Class 5
Free Parms	7	11	15	--
Likelihood	-4,161.8	-4,161.9	-4,161.9	--
aBIC	8,357.0	8,376.0	8,395.0	--
Entropy	0.38	0.71	0.45	--
VLMR (p)	91.8 (0.12)	0.0 (1.0)	0.2 (0.15)	--
BLRT (p)	89.0 (0.12)	0.0 (1.0)	0.2 (0.15)	--

aBIC = adjusted Bayesian information criteria; VLMR = Vuong-Lo-Mendell-Rubin fit statistic; BLRT = bootstrap likelihood ratio test; -- analysis not run.

Table D-4: Fit indices for latent class analysis of retention outcome, screening retention

Model: Retention	Class 2	Class 3*	Class 4	Class 5
Free Parms	5	8	11	--
Likelihood	-2,482.6	-2,352.3	-2,246.3	--
aBIC	4,988.2	4,741.6	4,755.4	--
Entropy	0.91	0.90	0.78	--
VLMR (p)	5722 (<0.01)	260.5 (<0.01)	0.0 (1.0)	--
BLRT (p)	5487 (<0.01)	249.9 (<0.01)	0.0 (1.0)	--

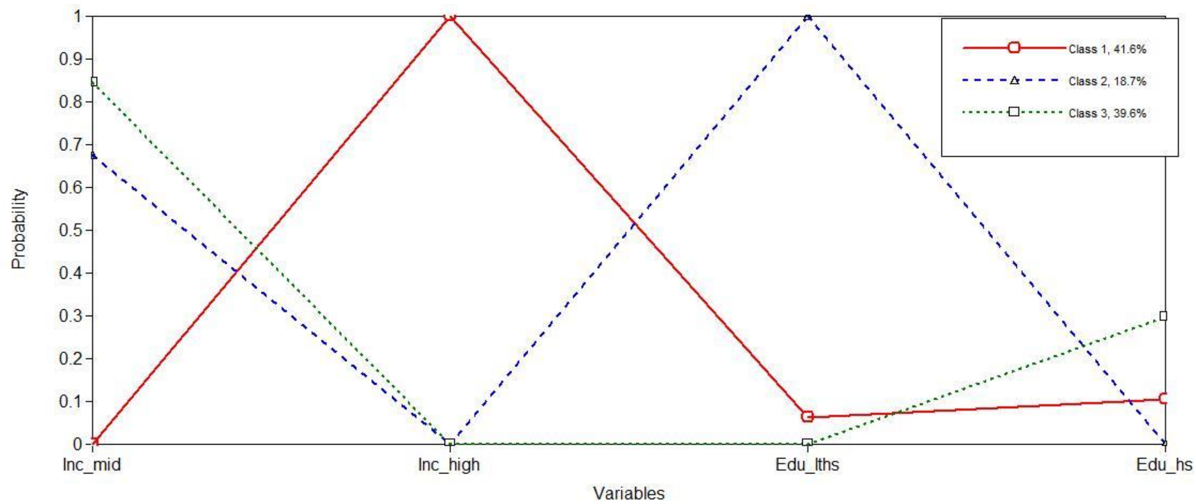
aBIC = adjusted Bayesian information criteria; VLMR = Vuong-Lo-Mendell-Rubin fit statistic; BLRT = bootstrap likelihood ratio test; -- analysis not ran; * model non-convergence.

The three-class latent profile plot for SES is shown in Figure D-1. Class one contained 1,041 individuals (41.6%), class two contained 459 individuals (18.7%), and class contained 937 individuals (39.6%). For class one, the probability for endorsing high household income was 100%. Approximately six percent endorsed less than high school education while 10% endorsed having at least a high school education. Due to the nature of the profiling, this class was characterized as high SES. In the second class, 68% endorsed middle household income while the probability of endorsing high income was 0%. The probability of a high school education was 100%. This group was categorized as low SES. For class three, 85% endorsed middle household income while 0% endorsed high income. The probability of endorsing less than high school education was 0% and approximately 30% endorsed a high school education. These characteristics identified this group as middle SES.

Figure D-2 contains a two-class latent profile plot for lifestyle habits. Class one contained 2,276 individuals (91.9%) and class two contained 161 individuals (8.1%). For class one, mean BMI was 25.7 (SD=4.2; results not shown), the probability of endorsing smoking and being physically active was 25.5% and 41.7% respectively. This class was characterized as fair to good lifestyle habits. For class two, mean BMI=38.3 (SD=4.4; results not shown). The probability of endorsing smoking and being physically active was 20% and 21%, respectively. This class was classified as having poor lifestyle habits.

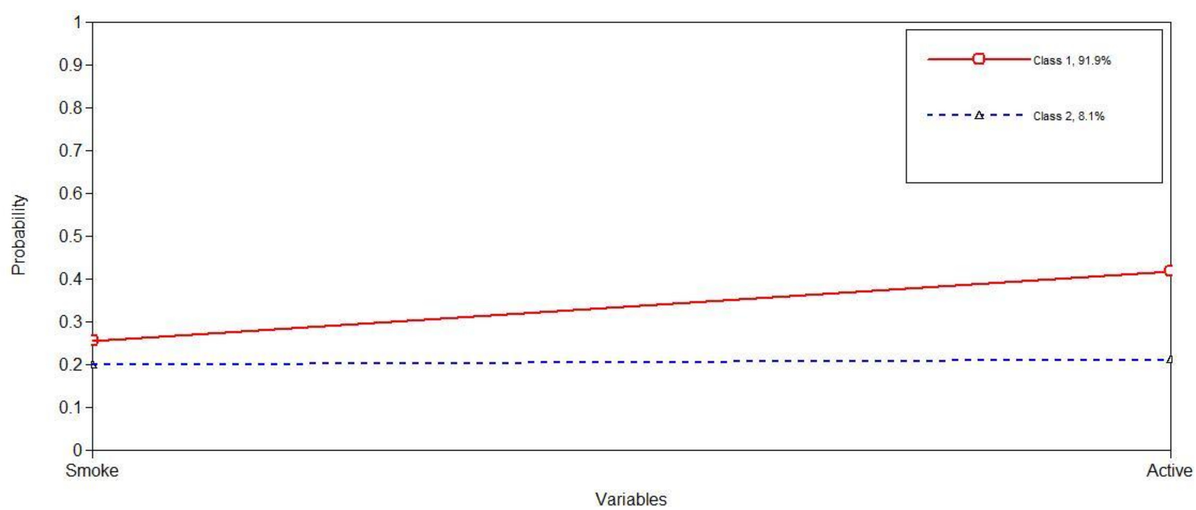
A two-class latent profile plot for retention is presented in Figure D-3. Class one contained 1,487 individuals (58.7%) and class two contained 950 individuals (41.3%). For class one, the probability of endorsing the first to fourth rescreens were 100%, 100%, 100%, and 95%, respectively; this class was categorized as high screening retention. For class two, its probability of endorsing the first to fourth rescreens was 28%, 5%, 0.1%, and 0%. Hence, this class was characterized as low screening retention.

Figure D-1: Latent profile plot of socioeconomic status latent variable, screening retention cohort



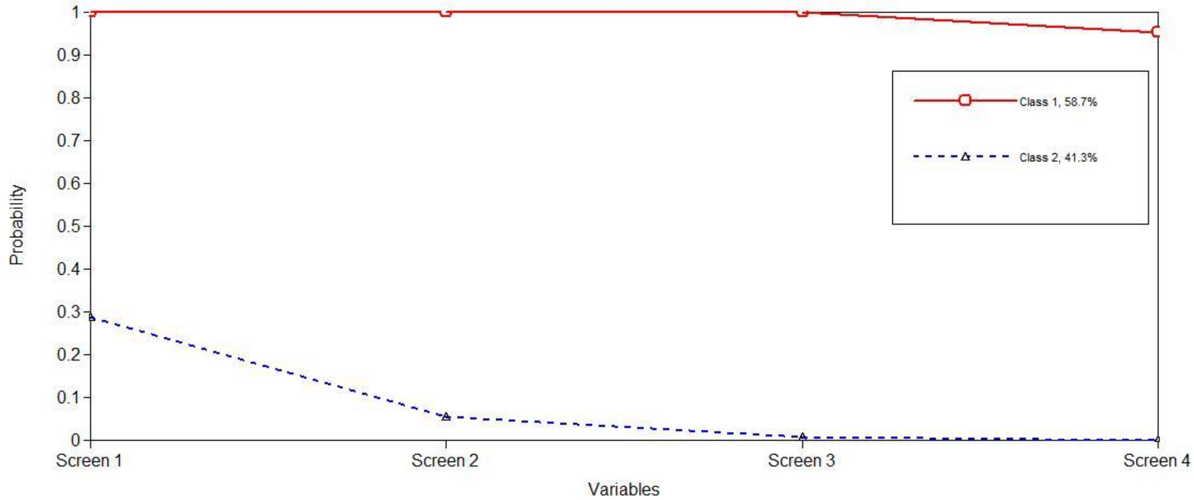
Inc_mid = middle household income; Inc_high = high household income; Edu_lths= less than high school education; Edu_hs = completed high school.

Figure D-2: Latent profile plot of lifestyle habits latent variable, screening retention cohort



Smoke = smoker; Active = physically active.

Figure D-3: Latent profile plot of retention status latent variable, screening retention cohort



Screen 1= first rescreen; Screen 2 = second rescreen; Screen 3 = third rescreen; Screen 4 = fourth rescreen

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