Original Article

Latent Class Analysis of knowledge, Attitude, and Practice of a Population-Based Sample of Iranian Pregnant Women toward COVID-19

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Abstract

Background: The aim of the study is to identify latent class (LC)-derived patterns of women's knowledge, attitude, and practice (KAP) toward coronavirus disease 2019 (COVID-19) in Iran. **Materials and Methods:** This cross-sectional survey of 2029 women, who participated in the PERSIAN Birth Cohort, was conducted in Isfahan, Iran. KAP was assessed by shortened and validated form of a recently used questionnaire in Iran. LC analysis was used to discover underlying response patterns of KAP toward COVID-19 using Mplus 8.0 software. **Results:** Three classes were identified: Class 1 (n = 514, 25.33%) "Low knowledge and poor practice, Class 2 (n = 423, 22.08%) "Moderate knowledge and proper practice," and Class 3 (n = 1092, 53.82%) "Low knowledge and proper practice." The lowest rate of positive attitude was seen in Class 3. Women living in rural areas, as well as those with lower education, were more likely to member classes with improper practice. **Conclusion:** The findings suggest that the LCA approach can provide important information reflecting different levels of adoption of protection toward COVID-19 infection. The results may be useful to conducting health-care programs during the outbreaks.

Keywords: *Coronavirus disease 2019, health knowledge, attitudes, practice, latent class analysis, pregnant women*

Introduction

The novel coronavirus disease 2019 (COVID-19) has been on the rampage ever since its outbreak in December 2019, affecting over 228.8 million people and claiming >4.62 million lives all over the world.[1] The brunt of the disease has been borne by different countries throughout the world.[2]

In the lack of any definitive therapy against COVID-19, it is necessary that people strictly obey social distancing, wearing mask hand hygiene advice.[3] However, following the "KAP theory," the adherence of people to these control measures would be primarily influenced by their knowledge, attitude, and practices (KAP) toward COVID-19.[4]

Pregnant women are particularly susceptible to respiratory pathogens because of their immunosuppressive state and physiological adaptive change during pregnancy.[5]

The KAP toward COVID-19 plays an integral role in determining a society's readiness to accept behavioral changes from the health authorities. KAP studies provide critical data to assess the type of intervention that might be appropriate to modify misconceptions about the disease.[6] Previous studies have shown the relationship between knowledge, attitude, appropriate practice, and preventive measures toward malaria, Zika Virus, and seasonal influenza during pregnancy.[7-9] It would be beneficial to evaluate the KAP related to COVID-19 among the public to provide better insight into addressing poor disease knowledge and the implementation of preventive strategies and health promotion programs.[10] On the other hand, the relationship between KAP is complex. Studies relating to the primary care setting examining these variables in the context of disease management used questionnaire data[10,11] which were computed as a percentage of correct responses or using a Likert scale or extracted scores.[12] However, rather than a variable-centered approach, the use of a person-centered statistical method like LC analysis (LCA) could offer an advantage for identifying latent subgroups and behavioral patterns. LCA is a method that assigns

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respondents to classes based on their responses to items in the questionnaire, rather than them being arbitrarily assigned to classes by the researchers.[13]

In particular, our research questions were the following: What subgroups of Iranian women in Iran can be identified concerning dimensions of KAP toward COVID-19? What is the relation between belonging to these subpopulations and a set of covariates?

Identifying subgroups could be useful for developing preventive strategies and health promotion programs to contour the COVID-19 outbreak.

Materials and Methods

Participants

This study was performed on women who participated in the national birth cohort study in Iran in the Isfahan center. The birth cohort study in Iran is an ongoing, multidisciplinary, longitudinal project linked to a multicenter study running in 5 different cities of Iran (Isfahan, Yazd, Semnan, Sari, and Rafsanjan) started in 2017.[14] The samples were selected from pregnant women. The study aims to investigate the impact of prenatal socioeconomic status, lifestyle, diet, and occupational and environmental exposures before and during pregnancy on some major health concerns in the ongoing child. Obtaining approval from Research Ethics Committees in Isfahan (IR. SEMUMS. REC.1399.081), in 3 weeks since May 15, 2020, all mothers who participated Isfahan birth cohort were called and asked to participate in a short telephone interview about COVID-19. The participants in the Isfahan birth cohort study were about 3000 child-mother pairs who all were invited to participate in the COVID-19 interview. To increase the participation rate, project-related social networks and media were used to inform them about the study.

Measures

KAP toward COVID-19 was assessed using the shortened form of a questionnaire developed in the Persian language as a self-administered researcher-made questionnaire by birth cohort investigators in the Sari center at Mazandaran University of Medical Sciences.[10] The questionnaire was qualitatively revised and summarized by an independent panel of experts in Isfahan centers and applied in a pilot study to re-evaluate its validity and reliability. The content validity was investigated by 10 experts. To investigate construct validity, we used latent class (LC) analysis to extract those items that have the most contribution to discriminate participants in terms of knowledge, practice, and attitude patterns. The approved tool was a 20-item questionnaire including 11 knowledge, 2 attitude, and 7 practice questions. The item content validity index (I-CVI) ranged from 0.68 to 1 and the scale CVI (S-CVI/Ave) ranged from 0.83 to 0.92.

The knowledge questionnaire consists of 11 items regarding clinical presentations, transmission routes, and prevention and control of COVID-19. For knowledge questions, there were three options, including "correct," "incorrect," or "do not know," which only received 1 score for the correct answer, while 0 score were given for the incorrect/do not know answers. Internal consistency of the knowledge measures was examined using Cronbach's alpha (11 items) which was 0.62 indicating acceptable internal consistency.[15]

To measure practice, participants were asked 7 questions about preventive measures, which were given a score of 1 for each person if they performed good practice and otherwise, a score of 0. Cronbach's alpha coefficient for practice (7 items) was 0.72.

The attitudes toward COVID-19 were assessed by two questions that asked participants (agree/disagree/unsure) about successful control of the pandemic in Iran and the world.

During the interview, participants were also asked about getting infected with COVID-19 in themselves or their family members and the main source of getting information about COVID-19. For the demographic and personal information, archived data was used.

Statistical analysis

Data were presented as numbers (percentage) and were depicted using radar plots.

LCA was used to discover underlying response patterns of KAP toward COVID-19. The method assumes that all associations between the included variables are entirely due to the existence of distinct subpopulations called LCs.[16]

Determination of the number of classes depends on a combination of factors including fit indices, class size, and interpretability.[17] The goodness of fit criteria, which, by definition, must be as small as possible[18] were Akaike's Information Criterion and Bayes Information Criterion (BIC) and sample size-adjusted BIC, as recommended to determine the optimal number of classes.[19] The higher entropy between classes was also considered in the model selection.[17] After selecting the best model, we assigned each participant to one class according to the highest computed probability of membership. Average posterior probabilities above 70% were indicated optimal fit.[18]

The association between the participants' assigned classes was also investigated in a posterior analysis using multinomial logistic regression. All analyses were performed using Mplus version 8.[20]

Results

In this study, 2029 women with mean ± standard deviation age of 30.9 ± 5.2 years participated (response

rate: 71.5%). Most of them (93.8%) were housewives. Among all 1188 (58.6%) were educated until high school level (diploma). The main source of information about COVID-19 was declared to be television by 81.2% of participants. Table 1 shows the characteristics of the participants. Seventy-eight (3.8%) individuals had a history of COVID-19 infection until our survey.

The frequency distribution of correct answers to knowledge questions and choosing proper practices declared by participants are presented in Table 2. The lowest percentage of correct answers belonged to questions "People with coronavirus are only carriers when they have a fever" (43.3%), and "Unlike colds, runny nose, and sneezing are less common in people infected with the coronavirus at the onset of the disease" (77.2%). The highest percentage belonged to the item "To prevent coronavirus infection, people should avoid going to crowded places as much as possible and not use public transportation" (94.6%).

The lowest percentage of proper practices belonged to items "Not using public transportation" (24.2%) and "Do not go to the hospital" (27.2%). The highest percentage belonged to the item "Do you wash your hands with soap for 20 s when you enter the house?" (96.9%).

Table 1: Participants characteristics

Variables	*n* (%)
Age (year)	
<25	220 (10.8)
25-29	514 (25.3)
30-34	749 (36.9)
35 and more	546 (26.9)
Job status	
Housewife	1903 (93.8)
Not-housewife	126 (6.2)
Education level	
High school and lower	1188 (58.6)
Higher than high school	841 (41.4)
Living place	
Urban	1975 (97.3)
Rural	54 (2.7)
Get infected	
Yes	78 (3.8)
No	1951 (96.2)
The main source of information about the disease	
Television	1647 (81.2)
Reputable medical sites (WHO, etc.)	72 (3.5)
Newspaper	6 (0.3)
Radio	5 (0.2)
Social media (Telegram, WhatsApp, Instagram, etc.,)	280 (13.8)
Family and friends	17 (0.8)
Colleagues	2 (0.1)

WHO: World Health Organization

The frequency distribution of the answers to the attitude items toward the danger of disease and overcoming it are as well presented in Table 2. More than 70.0% of the respondents agreed that COVID-19 will finally be successfully controlled. Rates of reporting "disagree" were 8.9% and 13.9% in the world and in Iran, respectively.

Latent class analysis

The model fit statistics derived from LCA suggested that a 3-class model was favored by the lowest fit indices and high entropy value [Table 3]. Class membership probabilities of the participants in a 3-class model. Were presented in Figure S1. Figure 1 illustrates the 3 classes identified using LCA. To simplify the interpretations, each class was assigned a summary label. The average posterior probabilities for all 3 classes were ≥0.9 (0.94 for Class 1, 0.89 for Class 2, and 0.92 for Class 3) [Table 4], implying an accurate classification of the participants to the correct class. Most people in the 3 classes were cared about wearing the mask and not going to crowded places (more than 86.0%), however, rates of proper practice related to other items were different among the 3 classes.

Class 1 (n = 514, 25.33%) "Low knowledge and poor practice:" Respondents assigned to Class 1 more likely had low knowledge [with probabilities of correct answers ranging from 0.00 to 0.35, Table 4] and perform a poor practice toward COVID-19. Moreover, more than 85% of people classified in this class had a positive attitude. The average class membership was 0.94.

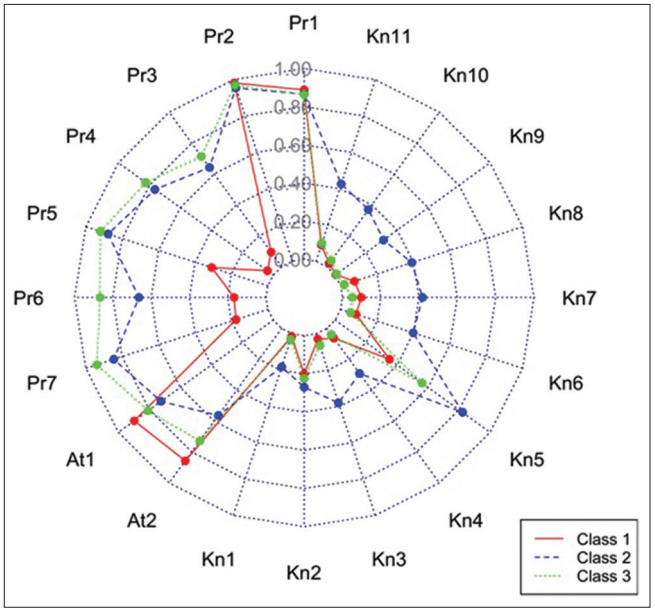

Figure 1: Radar plot comparing Class 1 – "Low knowledge and poor practice" (25.33%), Class 2 – "Moderate knowledge and proper practice" (22.08%), and Class 3 – "Low knowledge and proper practice" (53.83%) [Pr1-Pr7 referring to practice items, At1-At2 to attitude items, and Kn1-Kn11 to knowledge items listed in Table 2]

Table 2: Questionnaire of knowledge, attitude, and practice toward coronavirus disease-2019

Questions	*n* (%)
Knowledge (correct answer, percentage of the total sample)	
The main clinical symptoms of coronavirus include fever, fatigue, dry cough, and muscle aches	1908 (94.0)
Unlike colds, runny noses, and sneezing are less common in people infected with the coronavirus at the onset of the disease	1566 (77.2)
There is currently no effective treatment for coronavirus, but early symptomatic and supportive treatment can help most patients recover from infection	1775 (87.5)
Older people, who have a chronic illness, or immune system defects, and obese people are more likely to have the disease	1823 (89.8)
People with coronavirus are only carriers when they have a fever	879 (43.3)
Coronavirus is spread through the respiratory droplets of infected people	1750 (86.2)
Ordinary people can use masks to prevent coronavirus	1737 (85.6)
Children and young people also need to take steps to prevent coronavirus infection	1795 (88.5)
To prevent coronavirus infection, people should avoid going to crowded places as much as possible and not use public transportation	1878 (92.6)
People who come in contact with a person with coronavirus should be quarantined for 14 days	1810 (89.2)
Smokers and addicts are infected with the coronavirus	1686 (83.1)
Attitude (agree, disagree, I do not know, percentage of the total sample)	
Do you agree that coronavirus is finally being successfully controlled in the world?	
Yes	1649 (81.3)
No	181 (8.9)
Are you sure that Iran can win the battle against the coronavirus?	
Yes	1470 (72.4)
No	267 (13.2)
Practice (proper practice, percentage of the total sample)	
In recent days, do you wear a mask and gloves when leaving the house?	1765 (87.0)
Do you wash your hands with soap for 20 sec when you enter the house?	1966 (96.9)
Do not go to crowded places and shopping centers	926 (45.6)
Avoid sick people	781 (38.5)
Not using public transportation	492 (24.2)
Do not travel	715 (35.2)
Do not go to the hospital	552 (27.2)

Table 3: Fit statistics for latent class analyses

N. class	N. parameter	LL	AIC	BIC	ABIC	Entropy	Class size (%)
1	20	−18512.58	37065.15	37177.46	37113.92	-	100.0
2	41	−17222.08	34526.16	34756.39	34626.13	0.90	0.75, 0.25
3	62	−16646.12	33416.24	33764.39	33567.41	0.82	0.25, 0.21, 0.54
4	83	−16455.88	33077.76	33543.83	33280.13	0.83	0.17, 0.20, 0.09, 0.54

AIC: Akaike's information criterion, ABIC: adjusted Bayes information criterion, BIC: Bayes information criterion, LL: Log likelihood

Class 2 (n = 423, 22.08%) "Moderate knowledge and proper practice:" Individuals assigned to Class 2 were more likely to have proper practice (probability ranged 0.65–0.96) and moderately knowledgeable (probability of correct answer to the items ranged 0.18–0.82). The average class membership probability was 0.89. Furthermore, the lowest rate of positive attitude was seen in this class.

Class 3 (n = 1092, 53.82%) "Low knowledge and high practice:" Is characterized by individuals that are more likely to have proper practice but their knowledge about COVID-19 is not high. The average class membership was 0.93.

Association with demographic variables

Table 3 presents the association of LCA-derived classes and demographic variables using multinomial logistic regression. Class 1, the class with a low probability of proper practice and knowledge, was deployed as the reference. The odds ratio (ORs) indicates the odds of being in Classes 2 and 3 compared to Class 1. In both crude and multiple models, living in an urban area raises the chance of being in Class 2 (or equivalently the probability of proper practice within moderate knowledge) ($P < 0.001$) and Class 3 (increasing probability of proper practice) [Table 5].

Table 4: Class membership probabilities

Questions	Class 1	Class 2	Class 3
	Low knowledge and poor practice (*n*=514)	Moderate knowledge and proper practice (*n*=423)	Low knowledge and proper practice (*n*=1092)
Pr1	0.89	0.87	0.86
Pr2	0.98	0.96	0.97
Pr3	0.09	0.64	0.71
Pr4	0.04	0.76	0.82
Pr5	0.31	0.88	0.92
Pr6	0.17	0.66	0.87
Pr7	0.18	0.85	0.94
At1	0.90	0.73	0.81
At2	0.86	0.56	0.73
Kn1	0.01	0.18	0.03
Kn2	0.20	0.27	0.22
Kn3	0.03	0.38	0.06
Kn4	0.06	0.29	0.04
Kn5	0.35	0.82	0.56
Kn6	0.08	0.40	0.05
Kn7	0.10	0.42	0.05
Kn8	0.08	0.39	0.02
Kn9	0.00	0.31	0.01
Kn10	0.02	0.37	0.04
Kn11	0.09	0.43	0.10

Pr1-Pr7 referring to practice items, At1-At2 to attitude items, Kn1-Kn11 to knowledge items listed in Table 2

Table 5: Association of the identified class of knowledge, attitude, and practices with demographic variables

Variables	Class 1	Class 2	Class 3	Crude model[a]		Multiple model[a]	
				Class 2 OR (95% CI)	Class 3 OR (95% CI)	Class 2 OR (95% CI)	Class 3 OR (95% CI)
Age	31.14±5.33[b]	30.93±5.31	31.41±5.38	0.99 (0.97-1.02)	1.01 (0.99-1.03)	1.00 (0.97-1.02)	1.01 (0.99-1.03)
Job status							
Housewife	486 (94.6)[c]	401 (94.8)	1016 (93.0)	1.05 (0.59-1.86)	0.77 (0.49-1.20)	1.13 (0.62-2.04)	0.87 (0.55-1.39)
Not-housewife	28 (5.4)	22 (5.2)	76 (7.0)	1.0	1.0	1.0	1.0
Education level							
High school or lower	320 (62.3)	248 (58.6)	620 (56.8)	0.86 (0.66-1.12)	0.80 (0.64-0.99)	0.87 (0.66-1.14)	0.83 (0.67-1.04)
Academic degree	194 (37.7)	175 (41.4)	472 (43.2)	1.0	1.0	1.0	1.0
Living place							
Urban	480 (93.4)	415 (98.1)	1080 (98.9)	3.67 (1.68-8.03)	6.38 (3.27-12.42)	3.60 (1.64-7.91)	6.39 (3.26-12.52)
Rural	34 (6.6)	8 (1.9)	12 (1.1)	1.0	1.0	1.0	1.0

[a]Multinomial logistic regression with Class 1 as reference. Class 1: Low knowledge and poor practice, Class 2: Moderate knowledge and proper practice, Class 3: Low knowledge and proper practice, [b]Mean±SD, [c]*n* (%). CI: Confidence interval, OR: odds ratio, SD: Standard deviation

Discussion

LCA is a statistical method for identifying unmeasured class membership among subjects using categorical and/or continuous observed variables. LCA provides some advantages over other clustering methods, allowing the comparison to be statistically tested so that the decision to follow a specific model is less subjective.[21]

Our results obtained from LCA highlight that KAP toward COVID-19 is heterogeneous among Iranian woman participants. Specifically, we identified three LCs related to "Low knowledge and poor practice" (Class 1, 25.33%), "Moderate knowledge and proper practice" (Class 2, 22.08%), and "Low knowledge and proper practice" (Class 3, 53.82%).

Several studies evaluated the KAP toward COVID-19 in people from all over the world. These studies have investigated the awareness, believes toward the disease, and preventive behaviors. Previous studies have been done among the general population,[11] hospital staffs,[22,23] students,[12] and women; however, to the best of our knowledge, this is the first survey that provides a timely insight into the pattern of KAP toward COVID-19 through LCA.

Although according to the "KAP theory," we expected the acquisition of the right knowledge leads to the generation of attitudes, then adoption practice toward COVID-19, we investigated that the majority of our population did not follow this process. Despite low knowledge in Class 3, containing about half of the sample, we observed proper practice in this class, which surprisingly indicated that it is not significant what people know about COVID-19, it is important what people implement or can implement toward COVID-19. In this regard, we should consider the fact that the proper practice might be a consequence of anxiety or a social adaptation during the outbreak not an outcome of proper knowledge.[24,25] Another reason for finding a subgroup with low knowledge and proper practice may arise from that the underlying population in our study was pregnant women or the mothers of young children, who are classified in high-risk groups.[26] Thus, they may be more careful about the infection with more adherence to protocols and social distancing during the pandemic, even if they do not have high knowledge about the disease.

We showed that most people in the 3 classes were cared about wearing masks and washing their hands properly, and regularly, however, rates of proper practice related to other items were different among the 3 classes. The most important difference between Class 1 and Class 3 was mostly related to Pr3 (not going to crowded places and shopping centers), Pr4 (avoiding sick people), Pr5 (not using public transportation), Pr6 (not traveling), and Pr7 (not going to the hospital without an acceptable reason). Now, the question is that despite low knowledge in both Classes 1 and 3, what makes people have poor or proper practice? We could not answer this question with certainty, based on our findings; however, we suggested investigating the probable reasons in future studies. We think that it might relate to people's preference to be in communities, anxiety about financial hardship, the government policies toward the outbreaks, or the lack of infrastructure needed in society to deal with pandemic crises in low developed regions.[27-30] This difference between Classes 1 and 3 reflected the importance of social distancing that was less observed among the participants in Class 1, leading to poor practice among them. Furthermore, previous studies showed the importance of social distancing in communities during pandemics.[31,32]

In Class 1 with improper practice, there was a more positive attitude. A positive attitude may be a potential reason to care less about healthy behavior. This result is similar to a previous study that reported positive attitude and low practice in their participants.[33] However, some other studies indicated that having more frequent prevention practices was associated with a positive attitude.[34,35]

While rural residence was more likely to member Class 1 with improper practice, specific policies for rural residence might improve the preventive measures toward COVID-19. This finding is similar to a previous study by Chen and Chen published in 2020, that showed rural residents were less likely to perform preventive behaviors and more likely to have lower levels of information appraisal skills.[36] Thus, tailoring health messages to meet rural populations' unique needs can be an effective strategy to promote preventive health behaviors against COVID-19. Lai *et al*. explained that the type and quality of housing, physical morphology (density, land use heterogeneity, configuration, and design, locations of destinations, and accessibility) as well as the quality of infrastructures, and level of services are the key attributes that influence the populations toward pandemic crisis.[37] The current results showed the particular consideration needed to be implemented in rural regions. Women with lower education levels were as well more likely to member classes with an improper practice that is in line with dome previous studies.[38,39]

Study limitations and strengths

Our study, working to quickly capture the KAP of a specific population during the second wave of COVID-19 in Iran, clearly has limitations. First, this survey was done among a selected group of women in Isfahan who were all active participants in the PERSIAN Birth Cohort study and were pregnant or have a child under about 3.5 years old. Second, these findings may have limited generalizability, especially for the male gender and old age population. Third, our outcomes revealed only the initial fundamental knowledge of COVID-19, attitudes, and a limited set of practices through a self-reported questionnaire. Data capture on psychological conditions and behaviors, the effect of time, and governmental decisions on the KAP during a pandemic period suggest being considered in future studies.

Along with all limitations, the use of LCA allowed us to cluster participants according to the similarity of their KAP, instead of using arbitrary scores. Furthermore, LCA enabled the identification of population groups, which can be targeted through future tailored interventions. Moreover, we used a previously tested questionnaire, which contributed to the validity of our study.

Conclusion

We investigated the latent subgroups of women in terms of KAP toward COVID-19. Determining classes through modeling with latent variables, without imposing predefined categories, enabled us to characterize behavior types with regard to this widespread infection. Gaps in some aspects of knowledge and practice should be planned specifically for target populations among women who may face greater health hazards during the COVID-19 pandemic.

Data availability statement

All data collected, without personally identifiable information, is available as electronic supplementary material.

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Conflicts of interest

There are no conflicts of interest.

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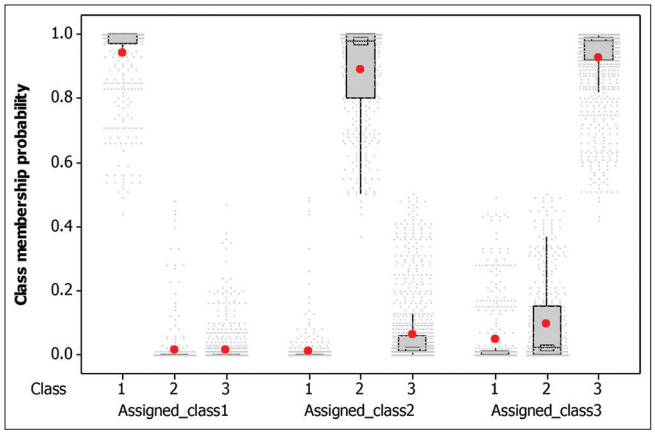

Figure S1: Class membership probabilities of the participants in a 3-class model. Results demonstrate that for each identified class, the probability of assignment to that latent class was > 0.90 on average