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## Association of bowel and tear suppression with coronary artery disease: A case control study



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## ABSTRACT

**Background:** Coronary Artery disease (CAD) accounts for one-third or more of all deaths in individuals over 35 years of age. In Ayurveda, umbrella term Hrdroga encompasses the concept of CAD. *Vegadharana*, suppression of natural urges is a lifestyle error that has been denoted as a potential risk factor of Hrdroga, but there is a lacuna of convincing research works.

**Objective:** The present study is designed to assess and evaluate the association of *Purisavegadharana*, *Baspavegadharana* (bowel, tear suppression) with CAD.

**Materials and methods:** Study followed case-control design; Cases (110) were patients aged above 18 years of either sex, diagnosed with CAD in a duration less than or equal to 10 years, attending outpatient department (OPD) of an Allopathy and *Ayurveda* hospital. The controls (110) included hospital controls from same hospitals. Exposure status was assessed through Case Record Form (CRF), Bowel suppression and Tear suppression assessment Questionnaires, interview with patients and scrutiny of past medical records. Odds ratios and chi-square tests were computed. Receiver Operating Characteristic (ROC) curves of logistic regression models fitted were generated and optimal cut-off points for bowel and tear suppression scores were derived through Youden index.

**Results:** Tear suppression and bowel suppression showed odds ratio of 4.47 and 2.30 respectively. Other commendable predisposing factors were age above 60 years, family history of disease and use of medication. Highest odds ratio from logistic regression was for palpitation (8.67) and followed by tobacco use (6.23).

**Conclusion:** Study indicated high association of bowel and tear suppression with CAD along with other predisposing factors, prominent of which were palpitation and use of tobacco use.

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## 1. Introduction

Coronary Artery disease (CAD) is considered as one of the major cause of death and disability in both developed and developing countries [1]. Studies reveal that behavioral risk factors such as tobacco use, unhealthy diet and obesity and physical inactivity are modifiable risk factors of CAD [2]. Lifestyle factors, health behavior, environmental factors and genetic factors are projected as risk factors for the development of CAD. The prevalence of risk factors among healthy individuals expounds the probable occurrence of CAD in near future [3]. The implementation and maintenance of

healthy lifestyle behaviours are considered the rate limiting step in cardiovascular disease prevention. An ideal shift from a focus on treating individuals with established CAD to the prevention of disease in those at risk has been contributed by Framingham and other epidemiological cohorts studies [4].

The epidemiological transition views the period of mid nineteenth century as the period of transition from infectious to non infectious disease and increase in lifestyle diseases such as cardiovascular diseases [5]. However there exists a much earlier description in Ayurveda regarding importance of *Hrdroga*, *Hridayamaya* and *Hridaya sula* [6]. The etiological factors of *Hrdroga*, according to Ayurveda, are categorized into three groups: dietetic factors, somatic and psychological factors. *Vegadharana* (suppression of natural urges) a pertinent lifestyle error is labelled under somatic factors causing Hrdroga [7].

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*Purisavegadharana* (bowel suppression) and *Baspavegadharana* (tear suppression) have been attributed to *Hrdyoparodha* (oppression in cardiac region) and *Hrdruk* (cardiac pain) [8–10]. Coronary Artery Disease is the most common cause of angina and acute coronary syndrome; characterized by central chest pain and tightness, heaviness or constriction in the chest respectively [11]. In Coronary Artery Disease, the etiology is generally discussed in terms of “risk factors”; where risk factor is an attribute or exposure that is significantly associated with the development of a disease and can be modified by intervening, which reduces specific outcomes [12]. Risk factor identification has contributed to a significant decrease in CAD mortality rates [13]. *Vegadharana* is a risk factor for *Hrdroga* and since habitual suppression of natural urges is a modifiable behavior, it comes under the purview of behavior change [7,14]. However there exists a lacunae of research work establishing the association of *Vegadharana* as risk factor of the outcome *Hrdroga*, followed by which it could be considered in behavior change process. Epidemiological studies are required to provide relevant evidence of an association of suspected risk factor and disease [15]. The exposure factors were selected on the basis of classical references. The components of systematic idea generation, expert consensus, feasibility, measurability and pliability to behavior change were taken into account while settling on two urges selected for the study. *Purisa* and *Baspavegadharana* encompasses the physical and psychological perspectives of risk behavior. This behavior change process enables transition from an unhealthy to a healthy lifestyle and follow the same in the longer span [16]. This would attribute to the primary aim of *Ayurveda*; prevent diseases by following a healthy lifestyle [17]. Though some research projecting aspects of bowel and tear relationship with CAD is available, bowel and tear suppression in relation to CAD, remains unstudied [18–22].

The present study was initiated as epidemiological analytical study to identify exposure status of the selected risk factors namely *Purisavegadharana* (Bowel suppression), *Baspavegadharana* (tear suppression) and to find out the strength of their association with outcome, *Hrdroga*.

The aim of this study was to incorporate the importance of *Vegadharana* in prevention of chronic diseases. The objective was to assess the association between *Purisavegadharana* and *Baspavegadharana* with *Hrdroga* with special reference to CAD in patients of OPD settings of VPSV Ayurveda College Hospital, Kottakkal and ALMAS Hospital, Kottakkal, Kerala.

## 2. Materials and methods

### 2.1. Case control study

In order to study suspected risk factors; *Purisavegadharana*, *Baspavegadharana* and their association with *Hrdroga* with special reference to CAD, case control design was selected. It is designed primarily to establish the cause of the disease by investigating the association between ‘exposure to a risk factor’ and the ‘occurrence of the disease’ [23].

### 2.2. Study sample

The case–control ratio was maintained at 1:1 without matching. Total 220 participants, 110 cases and 110 controls, were enrolled in the study. The outcome variable was CAD and exposure variables were bowel suppression and tear suppression.

#### 2.2.1. Inclusion criteria of case

Patients aged above 18 years of either sex diagnosed with CAD (which is an impedance or blockage of one or more arteries that supply blood to the heart) in a duration less than or equal to 10

years with the help of documentary sources such as clinical records and medical reports like ECG, Treadmill test, Echocardiography and biochemical tests were taken as case group. Both incident and prevalent cases attending Cardiology OPD of ALMAS hospital, Kottakkal and OPD of VPSV Ayurveda College Hospital, Kottakkal were randomly allocated by cardiologist. Those willing to give informed written consent were included in case group.

#### 2.2.2. Inclusion criteria of control

Controls satisfied all eligibility criteria defined for cases, with exception of disease in question. Controls were drawn from the same source population from which cases were selected. In the present study, 110 hospital based controls with different diseases like low back ache, knee joint pain, arthritis, gastritis, asthma, thyroid, diabetes mellitus diagnosed in a time period less than or equal to 10 years were taken from OPD of ALMAS hospital, Kottakkal and OPD of VPSV Ayurveda College Hospital, Kottakkal. In control group, patients belonging to same catchment population (kottakkal area) were selected to ensure that they are subjected to the same selective factors as the cases. The controls of the present study may be clubbed under incidence density sampling or risk set sampling, which is the one among the accepted control selection method [24]. The controls with different diseases were selected to see whether different comparisons yield the same conclusion [25,26].

#### 2.2.3. Exclusion criteria of case and control

Those with congenital heart disease, pregnant women, lactating mothers, terminally ill patients, patients with memory impairment and those unwilling to participate were excluded.

### 2.3. Ascertainment of exposure status

The exposure status was assessed through Case record form (CRF), bowel suppression and tear suppression assessment questionnaires, interview with the patients and review of past medical records.

#### 2.3.1. Questionnaire preparation

Bowel suppression assessment questionnaire (Table S1) was framed by considering consequences of *Purisavegadharana*, symptoms due to vitiation of *Purisavahasrotas* and situations of voluntary suppression in daily life activities, in certain situations of life since 1 year or more. The questions were divided into three sections. The questions dealing with *Purisavahasrotodushti lakshanas*, voluntary suppression of bowel movements in certain situations of life and consequences of *Purisavegadharana* were included in first, second and third section respectively. This pattern was followed in asking the questions.

Tear Suppression Assessment Questionnaire (Table S2) tried to capture why and how people regulate crying in their everyday lives and explore the intra - inter personal motives for regulation of crying [27]. The Becks Depression Inventory Scale was also taken into consideration during the designing phase of the questionnaire [28]. In each section, the first question was on crying in certain situations in life and the succeeding one was related to suppression in that particular situation. The first section was on questions related to sorrowful situations in life, the second section on questions related to self-esteem and social desirability, third section was on questions related to life events and memorable events and the fourth section was on stressful situations in family issues, jobs etc. In the fifth section, questions were on other negative emotions and death. The last question was on how the participants felt after crying. The above-mentioned pattern was followed in asking the questions. Assessment of sleep, dietary habits and lifestyle patterns of both case and controls were included in Case Record Form.

After completion of item generation and response scaling, each questionnaire comprising of with 22 questions was postulated. The questions placed in a logical order were translated to Malayalam and back translated. Pretest was done. The translated questionnaires in native language were used to collect data.

The following steps were taken to maintain the robustness of the questionnaire in the absence of a standardized questionnaire. The Expert consensus on the content and pattern of the questions were obtained from four eminent *Ayurveda* physicians of VPSV *Ayurveda* College Hospital, Kottakkal and two cardiologists of Almas Hospital, Kottakkal (having clinical and practical experience of 10 years). A pilot interview was carried out among 20 patients in the OPD settings of VPSV *Ayurveda* College Hospital, Kottakkal to assess feasibility of the study. The questionnaires were reframed and streamlined following cognitive reasoning of participants and a pretest was done. The study was approved by Institutional ethics committee (IEC) prior to the starting of work (Approval no: Ref: IEC/CL/22/17 dated 21-04-2017).

In this study, reliability of the questionnaire was assessed using Cronbach's alpha and split-half method. For bowel suppression index based on 22 questions, Cronbach's alpha worked out to 0.802 showing strong internal consistency for the measure. The split-half method showed that 'the scale means if item deleted' was having similar values which indicates the good consistency between questions. None of the items when deleted showed an increase in Cronbach's alpha indicating that no item was superfluous in the scale.

For tear suppression index based on 22 questions, Cronbach's alpha worked out to 0.858 showing strong internal consistency for the measure. The split-half method showed that the 'scale means if item deleted', resulted in a marginal increase to the order of 3rd decimal in Cronbach's alpha for some of the questions indicating that no item was superfluous in the scale.

### 2.3.2. Interview/medical records

Written permission was obtained from the concerned authorities of the hospitals. After getting the written consent from the participants, data was collected by filling the CRF and questionnaires. One-to-one interview (Face-to-Face interview) method with guided approach was adopted. Patients were informed about the anticipated time duration required for the interview and the session was started with an introductory message. The purpose of the study, what is expected from them and the expected participant benefit (medically) following the study were explained to the participants. The interview sessions were audio-recorded in addition to the recorded notes. The questions related to the present condition (associated with disease) were put forth first followed by a pattern that helped to draw out past information regarding their personal history, dietary pattern and natural urges.

### 2.4. Medical records scrutiny

The details regarding onset and duration of disease, the particulars of medical checkups and medications, the in-depth history of the disease and past illness associated with it along with anthropometric measurements were obtained and details obtained were noted down in CRF. Reports of electrocardiogram (ECG), Treadmill test and biochemical tests were also obtained from medical records. In the control group also, the same exercise was carried out.

### 2.5. Bias control

In order to avoid selection bias, effort was done for appropriate choice of case and control. The bystanders were included as key informants and those cases with chronic memory impairment were excluded to avoid recall bias. The key informant assistance was

cardinal in clarification regarding medical health record [29]. The investigator or interviewer was made 'blind' to the case/control status of the study subjects to avoid observer bias. The responder bias was minimized by keeping the study members unaware of the hypothesis under study and, wherever possible, ensuring that both cases and controls had similar incentives to remember past events.

### 2.6. Statistical analysis

Odds ratios were computed to measure the association of the disease with various risks, dietary and socio-demographic variables. Significance of association was ascertained through chi-square tests. Tear and Bowel suppression scores were obtained by adding up the scores obtained on individual questions related to these features. Special attention was given to bowel and tear suppression indices by fitting a logistic regression model [30] with disease category as dependent variable, assigning 1 for cases and 0 for control. Receiver Operating Characteristic (ROC) curves were generated and optimal cut-off points for bowel and tear suppression scores were derived through Youden index. Youden index maximizes the sum of sensitivity and specificity. Based on the optimal cut-off points, bowel and tear suppression classes were formed and odds ratios and chi-square values were worked for these factors as well.

The optimal cutoff points for both bowel and tear suppression were obtained using Youden index. These cutoff points were used for working out the AUC of the ROC and the chi-square statistic, optimum categorization was done for procuring chi-square value. The Youden index maximizes the sum of sensitivity and specificity which in a way minimizes the misclassification errors in prediction. The AUC of the ROC indicates how well we are able to predict true positives and true negatives of the incidence of CAD.

Factors which showed significant association in univariate analysis were picked up and related to the category (case/control) through a multiple logistic regression model. The variables which were significantly associated with Cases in univariate analysis were subjected to multivariate analysis of binary logistic regression. This was done to know the independent risk factors for case.

In multivariate analysis of binary logistic regression, all variables were taken simultaneously; here the analysis was done after considering the presence of all other variables; all other variables were held constant at a constant level.

The fitted model was validated using 10-fold cross validation. A *k*-fold cross validation happens with separation of *k* observations randomly from the estimation dataset and predicting the response level for the separated observations and repeating this process, each time selecting a different sample of *k* observations exhaustively. The results are then compiled across multiple samples drawn which give a highly validated accuracy level in place of that obtained through a single pair of training and validation datasets.

## 3. Results

Summary tables of the disease category variable (case/control) and the different exposure factors are provided in Table 1. Chi-square values for the following factors viz., Religion, Educational status, Diabetes mellitus, Hypertension, Alcohol usage, Oil usage, Ghee usage, Diet pattern, Timing of lunch and Exercise were non significant and so were not considered for further analysis.

The odds ratios with their confidence limits are presented in Table 2 along with chi-square statistics and associated P values for each of the exposure and other factors that showed significant association. The results of logistic regression of the disease category

**Table 1**  
Summary tables of exposure variables vs. category levels.

Variable	Level code	Label	Control	Case	Chi-square	P value
Age group	≤60 years	≤60 years	85	56	16.61	<0.001
	>60 years	>60 years	25	54		
Gender	1	Male	49	65	4.66	0.0309
	2	Female	61	45		
SE status*	1	Lower	38	20	27.35	<0.001
	2	Lower middle	58	44		
	3	Middle	10	41		
	4	Upper middle	4	4		
	5	Upper	0	1		
Occupation	0	Manual labour	19	20	14.43	0.006
	1	House wife	14	7		
	2	Unemployed	55	37		
	3	Employed	9	17		
Fam-history*	4	Business	13	29	14.34	<0.001
	0	Absent	105	86		
	1	Present	5	24		
Tobacco use	1	Yes	16	49	23.78	<0.001
	2	No	94	61		
Beverage	1	Yes	7	17	4.67	0.0306
	2	No	103	93		
Medication	1	Yes	43	83	29.72	<0.001
	2	No	67	27		
Palpitation	1	Yes	5	42	37.04	<0.001
	2	No	105	68		
Sleep	1	Normal	100	88	5.27	0.0217
	2	Disturbed	10	22		
DLP*	0	Absent	44	63	6.57	0.0104
	1	Present	66	47		
Bowel suppression	≤13.6	Score ≤ ≤13.6	62	42	12.63	<0.001
	>13.6	Score > > 13.6	48	68		
Tear suppression	≤33	Score ≤33	79	35	35.25	<0.001
	>33	Score >33	31	75		

\*SE status = Socio-economic status, Fam-history = Family history, DLP = Dyslipidemia.

variable with bowel and tear suppression scores are given in Table 3 along with optimal cut-off scores.

Bowel suppression showed a significant relation with the disease. The model attained an overall accuracy level of 0.59. The optimal cutoff score obtained through Youden index came to 13.6. Tear suppression had a stronger relation with the disease with an accuracy level 0.70. The optimal cutoff value worked out to 33.

The results of stepwise logistic multiple regression of category levels with exposure factors having nonzero ‘importance metric’ are given in Table 4.

Many non-significant variables were eliminated in the first round through chi-square analysis and in the second round through stepwise regression. In the final model, only those exposure factors which showed significant association with CAD were retained. For the purpose of regression analysis, all the predictors were converted to dichotomous variables.

**Table 2**  
Odds ratios of risk and socio-demographic variables.

Variable	Level	Odds ratio	P value
Age group	>60 years	3.26	<0.001
Gender	Male	1.79	0.0427
Socio-economic status	Upper	4.89	<0.001
Occupation	Unemployed	2.86	<0.001
Family history	Present	5.82	<0.001
Tobacco use	Present	4.68	<0.001
Beverage	Present	2.68	0.0498
Medication	Present	4.75	<0.001
Palpitation	Present	12.83	<0.001
Sleep	Disturbed	2.49	0.0342
Dyslipidemia	Present	2.00	0.0150
Bowel suppression	>13.6	2.08	0.010
Tear suppression	>33	5.41	<0.001

The 10-fold cross validation accuracy for the multiple regression model was 0.8273. The regression coefficients of all the variables included in the model were significant. The highest odds ratio was shown for palpitation (8.67) followed by the use of tobacco (6.23). Having palpitation and use of tobacco carried higher risk of contracting the disease. Other commendable predisposing factors were, being older than 60 years, belonging to upper social class, history of Coronary Artery Disease in the family and use of medication. Tear suppression had a prominent role showing an odds ratio of 4.47 and bowel suppression showed a lower value of 2.30 for odds ratio. The odds ratios from multiple regression are not directly comparable with that given in Table 2 because in multiple regression, presence of the complete set of predictors is taken into consideration and the regression coefficients or the corresponding odds ratios have a restricted interpretation that they show changes or relative risk associated with any particular risk factor, keeping all other factors at a fixed level. Hence for ordinary association analysis, univariate odds ratios are good enough but for identifying or predicting potential CAD cases, the regression model becomes useful. Classificatory analysis is not possible through univariate association analysis.

#### 4. Discussion

To the best of our knowledge this is probably the first study exploring the association between bowel and tear suppression with regard to CAD. In the present study, an association was found between Purisavegadharana (bowel suppression) and CAD and also Baspavegadharana (tear suppression) and CAD. Several other known risk factors were studied and significant association was obtained for age, sex, socio economic status, family history of

**Table 3**  
Logistic regression of disease category variable with bowel and tear suppression scores.

Predictor	Regression coefficient	SE (Regression coefficient)	P value	Accuracy	Optimal cut-off score
Bowel suppression				0.59	13.6
Intercept	-0.4746	0.2688	0.0775		
Bowel suppression	0.0282	0.0138	0.0416		
Tear Suppression				0.70	33.0
Intercept	-2.1232	0.4663	<0.001		
Tear suppression	0.0637	0.0132	<0.001		

Coronary Artery Disease, usage of other medications before diagnosing the disease, palpitation, tobacco usage and disturbed sleep.

In this study, majority of the cases were having the disease within 1–5 years duration; in a few cases, the disease duration was above 5 years. Chang et al reported on piles and fistula association with higher risk of CAD in considerable number of cases [31]. *Parikartika* (Anorectal fissure), *Adhmana* (distention of abdomen) and *Pakvashaya sula* have been accounted as complications of *Purisavegadharana* [32,33] and these features were found to be higher in the case group. When compared to control, the cases reported *Purisavahasroto dushti lakshana* like difficulty in passing stools, passing in small quantity, hard stools, passing stools many times in a greater proportion [34]. Previous studies have stated that patients with upper gastrointestinal complaints like abdominal distention and epigastric pain can induce cardiovascular disease [35]. In this study both cases and controls had reported distention of abdomen, hinting that control are always at the risk of becoming cases [25].

The majority of female cases who experienced bowel suppression reported constipation. This is in alliance with the study by McCarthy et al. where females with moderate and severe constipation (14.2 and 19.1 events/1000 person-year), respectively experienced higher cardiovascular events when compared with women with no constipation (9.6/1000 person-years) [36]. Further in most of the cases, laxatives were prescribed by physicians along with Clopidogrel tab. In male cases, bowel suppression was seen mostly during long-distance travel which was integral to their professional responsibility. It becomes pertinent to explore the extent and causes of work stress relationship with health behavior [37], since epidemiological study reveal that co manifestation of health risk behaviors accelerate occurrence of lifestyle diseases such as CAD [38]. In the present study it was seen that majority of cases suppress bowel during working hours, before food intake, and while attending a function or meeting. Lack of toilet facility while travelling, lack of privacy, lack of cleanliness in toilet facilities and lack of time were reported to be common reasons for bowel suppression.

Tear suppression assessment questionnaire revealed that, three fourth of the cases when compared to one third of the controls have suppressed tears in stressful life situations. Self esteem deterioration and inhibition to 'emotional expression, were reported to be the main motive for tear suppression. This finding may be

considered along with an increasing awareness regarding link of self esteem and health behavior [39]. Most of the cases had been working abroad and were having habitual tear suppression owing to lack of companionship for sharing emotions. Emotion suppression increases sympathetic activation which might lead to chronic functional and structural changes of cardiovascular system that compromise its performance [40]. However there are studies stating that suppressing tears increases stress levels, and contributes to diseases which are aggravated by stress, such as high blood pressure, heart problems and peptic ulcers [41].

Thus in general terms *Vegadharana* can be considered under as health behaviors or health-related behaviors, which are dynamic actions engaged by individuals that affect health or mortality. The variability of such health behavior are seen over different phases of life, across setting and population [42].

Studies state that CAD incidence in men compared to women is approximately 3 times higher [43]. Previous studies state that men and women aged 55–64 years old demonstrated an incidence of myocardial infarction that was approximately eight times greater, compared to those less than 40 years old [44]. In tune with previous studies, the male participants above 60 years, were found to be at a greater risk of CAD in this study. Snowden et al., suggested that familial aggregation for coronary heart disease may result from predisposition to disease, possibly genetic that is not reflected in the measured levels of total cholesterol, systolic blood pressure or cigarette smoking [45]. Higher percentage of cases were having family history of CAD compared to control. The present study revealed the family history of CAD as an independent risk factor for the disease. A very high percentage of cases were having palpitation compared to control. This is supported by study of Weber et al. that the etiology of palpitations was cardiac in 43% of participants [46]. Hoevenaer-Blom MP et al., reported that short sleepers especially those with poor sleep quality have an increased risk of total Cardiovascular Disease (CVD) and CAD incidence [47]. In the present study also, disturbed sleep was seen in cases and found to be associated with CAD. Very high proportion of cases in this study were tobacco users and the risk of developing CAD was found to be higher in participants using tobacco than in non-tobacco users. Studies on combined effect of smoking on cardio vascular risk factors explain the part of its influence on peripheral and coronary arterial disease [48]. In this study, high proportion of cases was

**Table 4**  
Logistic regression with response variable with exposure factors.

Predictor	Regression coefficient	SE (Regression coefficient)	P value	Odds ratio
Intercept	-3.3848	0.5415	<0.001	0.03
Age group (>60 years)	1.1095	0.4107	0.0069	3.03
Gender (Male)	-1.0809	0.5354	0.0435	0.34
Socio-economic status (Upper)	1.3554	0.4855	0.0052	3.88
Family history (Present)	1.2050	0.7178	0.0932	3.34
Medication (Yes)	1.3617	0.4124	0.0010	3.90
Palpitation (Yes)	2.1603	0.5644	0.0001	8.67
Sleep (Disturbed)	1.2021	0.5941	0.0430	3.32
Tobacco (Yes)	1.8300	0.5791	0.0016	6.23
Bowel suppression (>13.6)	0.8337	0.3992	0.0368	2.30
Tear suppression (>33)	1.4983	0.4195	0.0003	4.47

found to be using allopathic medications for other medical conditions especially thyroid, before being diagnosed with CAD. Previous studies also had stated that adults with TSH  $\geq 10.0$  m U/L had a moderately increased risk [49].

In a study carried out to assess the role of various behavioral risk factors in the occurrence of CAD, the salt and oil intake per day were having significant association [50]. But in the present study a significant association of oil consumption and salt intake with CAD was not obtained.

The Framingham study found that total cholesterol levels are related to development of Coronary Heart Disease (CHD) in both men and women aged 49 years and older [51]. In this study, it was noted that about half of the cases and more than half of controls were having history of diabetes mellitus, hypertension and elevated levels of cholesterol before being diagnosed with respective disease. This is supported by the studies suggesting that common lifestyle risk factors cluster among adult subjects and such accumulations have been repercussion for health promotion [38]. Hence it may be addressed with caution and attention from an epidemiological perspective.

The present study revealed that *Purisavegadharana* and *Baspavegadharana* are the risk factors associated with *Hrdroga*. *Vegadharana* is a modifiable behavior which can be considered as both primordial and primary prevention tool. Lifestyle changes including behavior changes and desirable health behavior is known to be cardinal for CAD prevention. Motivational interviewing is a form of patient counseling that has been found to be effective in reducing maladaptive behaviors and promoting positive health behavior changes [14]. Refraining from *Purisavegadharana*, *Baspavegadharana* can be done through this motivational interviewing. The relevance of the study may be understood in terms of the fact that, the information obtained from evidence based epidemiological studies are methodically imbibed into public health policy [52]. The scope of population and high risk approach in prevention of at risk behaviour and possibility of life style change advices, is worth considering [53,54].

It was seen during the study that recall of past events in personal history tend to be more accurate in newly diagnosed cases than in old cases as the recent cases were less likely to have changed their habits/exposure as a result of disease. In the present study majority of cases were newly diagnosed cases and this helped to eliminate difficulty in recalling past exposure. The response rate of patients varied considering social desirability and severity of illness; chronic cases were least inclined to respond. It was noted during the study that accurate measurements of past exposures were difficult to obtain in control group as they were not affected by serious conditions; so they made less effort to remember accurately their past exposures.

Limitations of this study include recall bias and difficulty in ascertaining the accuracy of medical records. The comparability for exposure assessment is not as straight forward for a case–control study as for a Randomized Clinical Trial. Matching was done to the extent possible by use of exclusion/inclusion criteria but confounding with obesity was not addressed.

## 5. Conclusion

Association analysis done through a case–control study at ALMAS Hospital and VPSV Ayurveda College Hospital, Kottakkal with 220 patients out of which 110 subjects having CAD, indicated that those having bowel suppression are at a greater risk of getting Coronary Artery Disease and this association was found statistically significant. Those having tear suppression are at a greater risk of getting CAD and this association was found statistically significant; along with several other predisposing factors, prominent of which

were palpitation and use of tobacco. The multiple regression model helped identifying the potential risk factors. The regression model would be useful for predicting the incidence of CAD as well. Epidemiological analytical study to assess the temporal causation of risk factors with outcome may be beneficial. A mixed model may also be considered to integrate qualitative and quantitative aspect of *Vegadharana*.

The knowledge, attitude and practice domain of *Vegadharana* as undesirable health behavior may be included in behavior change program including trans theoretical model of behavior change and health belief model [14]. Studies devoted to validation of questionnaires - to assess *Vegadharana* in different populations and exploring the association between *Baspavegadharana* with *Hrdroga* in accordance to personality type incorporating *Satvabala* are recommended.

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## Conflict of interest

None.

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## Appendix A. Supplementary data

Supplementary data to this article can be found online at <https://doi.org/10.1016/j.jaim.2020.11.007>.

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