Original Article

Correlation between Non-communicable Diseases and Curcumin Use

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ABSTRACT

Background: Non-communicable Diseases (NCDs) are increasing rapidly all over the world, on the other hand, curcumin has various medicinal properties against NCDs and it is a major ingredient in our household/recipes. So why can't we study such an important natural herb in preventing and treating various chronic diseases. Another important factor for the selection of this study was the outbreak of COVID-19 and people had increased awareness about turmeric/curcumin use during this pandemic situation. **Objectives:** To find out the prevalence of non-communicable diseases across various centers and correlate with the usage of curcumin in these centers and also to understand the global scenario of how curcumin is better utilized and what its position in India. **Materials and Methods:** A descriptive cross-sectional study was performed in Erode, Komarapalayam, Kallakurichi, Nagapattinam situated in the state of Tamil Nadu, India for a duration of 6 months. A simple random sampling method was adopted to choose the households and then a self-structured questionnaire has been given to collect the details like demographic and disease status with turmeric use and their awareness status. The Mann-Whitney U test was used to compare curcumin use related to non-communicable diseases. The p-value of <0.05 was considered as significant. **Results:** A total of 1276 households were included with 4495 family members; the majority of participants were female (99.7%). Among the population, the prevalence of non-communicable diseases is cardiovascular diseases (7.7%) followed by diabetes (7.6%), arthritis (3.6%), asthma (0.9%), cancer (0.1%), Alzheimer's disease (0.2), psoriasis (0.5%) and others (1.5%) include hypothyroidism, ulcer, and neuropsychiatric disorders. The average years of turmeric use (42.8 years) among the households and the average amount (1.8 g) of curcumin in their daily recipes were found along with the average daily curcumin use of 0.54 g. By applying the Mann-Whitney U test, there was a significant association between diabetes and arthritis with curcumin use was verified. **Conclusion:** The present study highlights that the prevalence of diabetes and arthritis was significantly associated with curcumin use. On the other side, people in India were more aware of curcumin as a medicinal herb and consumed higher amounts particularly during the COVID-19 pandemic.

Keywords: Curcumin, Non-communicable Disease, Diabetes, Arthritis, Correlation.

INTRODUCTION

Non-communicable diseases (NCDs) are one of the primary concerns for public health in the twenty-first century, not only through terms of the human misery they cause, but also in terms of the harm they inflict on the country's socioeconomic development. Every year, NCDs kill around 41 million people (71% of global mortality), including 15 million people between the ages of 30 and 69. The vast majority of NCD fatalities are controllable. Cardiovascular disorders (such as heart attacks and stroke) account for the majority of NCD mortality, or 17.9 million people each year, followed by malignancies (9.3 million), respiratory diseases such as chronic obstructive pulmonary disease and asthma (4.1 million), and diabetes (1.5 million). These four disease groups account for more than 80% of all premature NCD mortality.[1]

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NCDs are increasing quickly over the world and have reached epidemic proportions in many countries, owing largely to globalization, industrialization, and rapid urbanization, as well as demographic and lifestyle changes. According to World Health Organization (WHO) predictions, the overall yearly number of NCD deaths will rise to 55 million by 2030 if appropriate interventions for NCD prevention and control are not implemented. Every year, almost 5.8 million people (WHO report, 2015) die in India from NCDs (heart and lung diseases, stroke, cancer, and diabetes). This means that one in every four Indians is at risk of dying from an NCD before the age of 70.[2] According to Tamil Nadu: Disease Burden Profile, 1990 to 2016, 43.2% of overall mortality occur between the ages of 40 and 69, with 10.9% owing to cancer, cardiovascular diseases (40.4%), chronic respiratory illnesses (6.4%), cirrhosis (2.3%), and diabetes (12.2%).[3]

India's increasing urbanization is typical of a country transitioning from "developing" to "developed" status. Dietary changes, decreased physical activity, and an increase in obesity are common outcomes of this transition, particularly as cities become more densely populated. In India, the diet has been linked to an increased risk of chronic disease, although few of these correlations have been thoroughly researched or evaluated.

India's diet evolved over thousands of years and is based on a combination of religious and secular values. For instance, Ayurvedic medicine provides over 700 plant-based medications that contain spices and food additives to promote excellent health. Many of these foods, including turmeric (curcumin), cumin, chilies, kalakhar, Amrita Bindu, and several plant seeds, have been researched for illness prevention. Among the most studied in recent years is turmeric, an ingredient in the common Indian curry and spice that has been shown to be a potent antioxidant and anti-inflammatory agent with additional promise as a cancer preventive agent.[4]

In India, turmeric is used as a cooking spice to induce nice yellow-orange color and flavor in curries, pickles, and chutneys. It is used worldwide as a color-inducing agent as well as a preservative in American mustard, mayonnaise, butter, and margarine and has been designated as international food additive E100. So, this study aims to find out the prevalence of non-communicable diseases across various centers and correlate it with the usage of curcumin in these centers.

MATERIALS AND METHODS

Ethical Clearance

This study was approved by Institutional Ethics Committee, Ethics Committee for Research on Human Subjects (ECRHS), JKKMMRF's Annai JKK Sampoorani Ammal College of Pharmacy with reference number EC/PHARM.D/2021-05.

Study Setting: A Descriptive Cross-sectional study has been conducted in the Erode, Komarapalayam, Kallakurichi, Nagapattinam districts of Tamil Nadu for a duration of 6 months (From April 2021 to September 2021). Simple Random Sampling Method is adopted to choose the subjects who mets the inclusion criteria. Adequate measures are followed to avoid bias in the sample and the primary outcome was to find out the correlation between Non-Communicable Diseases and Curcumin Use.

Sample Size Determination: The sample size was determined by using this formula, with 0.95 Confidence Interval, Z is 1.96, if true prevalence, p= 0.1 and thus the minimum sample size determined was 138 per center.

$$n = \frac{Z^2 P(1-P)}{D^2}$$

Study Criteria

A self-structured questionnaire has been prepared to collect the details like demographic and disease status with turmeric use and their awareness status. It is randomly distributed to the households who meet the inclusion criteria as per the Kish method. People who are willing to participate in the study and those with the age between 18 and 80 were included irrespective of men and women. Those who are not giving consent, mentally retarded people, people with communicable diseases were excluded.

Statistical Analysis

The data collected were entered in Microsoft Excel Software and summarized by using Descriptive Statistics such as Frequency, percentage, mean, Standard Deviation, and Inter Quartile Range (IQR). The Mann-Whitney U test was used to compare curcumin use related to non-communicable diseases. The p-value < 0.05 was considered significant. Data analysis was performed by using SPSS version - 26.

RESULTS

A cross-sectional observational study was conducted in four centres and also through google forms for a duration of six months. About 1276 households participated with their 4495 family members to find the correlation between non-communicable diseases and curcumin use.

Centre-wise Distribution

Among the 1276 households, 300 each from Erode, Komarapalayam, Kallakurichi, Nagapattinam and 76 from google forms. Actually, we got 99 responses through google forms and took only 76 fully completed responses.

Gender-wise Distribution

Among the 1276 households, female percentage (99.7%) is more when compare to male participants (0.3%).

Age Wise Distribution

Out of 1276 participants, the majority of the households were in the age of 31-45 years (47.2%) followed by the age of 46- 60 years (30%), age of 18- 30 years (15.7), and the age of 61- 75 years (6.9%) and above 76 (0.2%).

Educational Status of Household

The majority of the households are in the 10th and Below category (48.8%) followed by illiterate (16.1%), Undergraduate (15.6%), 12th and Below (13.1%), Post Graduate (5%), and Others (1.3%).

Employment Status of Household

The majority of households were homemakers (2%) followed by private employees (30.9%), self-employed (9.3%), daily wages (8.9%), Government employees (4.7%), Students (2.2%), Farming (1.7%) and Others (0.2%).

Income Wise Distribution

According to income wise distribution, the majority of households are under 20,000 category (47.6%) followed by 20,000- 40,000 (40.9%) and above 40,000 (11.5%).

Residence

The majority of households are in rural population (57.1%) followed by urban population (42.9%).

Distribution of Family Member's Gender

Majority of family members were female which is 2396 family members (53.3%) and 2099 family members (46.7%) were male as represented in Table 1.

Distribution of Family Member's Age

Among the total study population, the majority of the family members (26.8%) fell under the categories of 18- 30 years and 31- 45 years followed by 46- 60 years (22%), below 18 years (17%), 61- 75 years (6.5%) and above 76 years (0.9%) as represented in Table 2.

Distribution of Family Members Educational Status

Among the total study population, the majority of family members are at 10th and Below category (44.7%) followed by Under Graduate (23.6%), 12th and Below (12.2), illiterate (10.9%), Post Graduate (5.5%) and Others (3.2%) as represented in Table 3.

Distribution of Family Members Employment Status

Among the total study population, the majority of private employees (31.6%) followed by students (24.4%), homemakers (17.6%), self-employed (9.6%), daily wages (6.1%), others (3.9%), Government Employee (3.8%) and Farming (3%) as in Table 4.

Prevalence of Non-communicable Disease

Out of total study population, majority of cardiovascular diseases (7.7%) followed by diabetes (7.6%), arthritis

Table 1: Distribution of Family Members Gender.

(*n* = 4495)		Frequency	%
Sex	Male	2099	46.7
	Female	2396	53.3

Table 2: Distribution of Family Members Age.

(*n* = 4495)		Frequency	%
Age	Below 18	764	17
	18 - 30	1204	26.8
	31 - 45	1206	26.8
	46 - 60	991	22
	61 - 75	291	6.5
	Above 76	39	0.9

Table 3: Distribution of Family Members Educational Status.

(*n* = 4495)		Frequency	%
Educational Status	Illiterate	488	10.9
	10th and Below	2009	44.7
	12th and Below	547	12.2
	UG	1060	23.6
	PG	247	5.5
	Others	144	3.2

Table 4: Distribution of Family Members Employment Status.

(*n* = 4495)		Frequency	%
Employment status	Private employee	1420	31.6
	Government employee	173	3.8
	Self employed	430	9.6
	Daily wages	274	6.1
	Farming	136	3
	Home maker	792	17.6
	Student	1096	24.4
	Others	174	3.9

Table 5: Prevalence of Non-Communicable Disease.

(*n* = 4495)	Frequency	%
Cardiovascular diseases	347	7.7
Diabetes	342	7.6
Asthma	41	0.9
Cancer	1	0.1
Alzheimer's Disease	3	0.2
Arthritis	161	3.6
Psoriasis	21	0.5
Others	67	1.5

Table 6: Amount and Duration of Turmeric Use.

(*n* = 1276)	Mean	S.D.
Since when you are using turmeric? (Years)	42.8	11.5
How much amount of curcumin did you use in your daily recipes? (Gram)	1.8	1.4
What is your monthly buying quantity of turmeric powder? (Gram)	129.1	86.5

(3.6%), asthma (0.9%), cancer (0.1%), Alzheimer's disease (0.2), psoriasis (0.5%) and others (1.5%) include hypothyroidism, ulcer and neuropsychiatric disorders as represented in Table 5.

Amount, Duration and Frequency of Turmeric use

The average years (42.8 years) of turmeric use among the households and the average amount (1.8 g) of curcumin in their daily recipes as in Table 6. To avoid bias, the amount of curcumin in use by the households was cross-checked by asking monthly buying quantity of turmeric powder. Then the frequency of turmeric use among the households was also shown the majority of 7 days (95.9%) followed by 3-5 days (2.2%) and 6 days (1.9%) as described in Table 7. The average daily curcumin used in their daily recipes divided by their family members of 4495 was found to be 0.54 g along with the standard deviation of 0.38 g.

Table 7: Frequency of Turmeric Use.

(*n* = 1276)		Frequency	%	Chi square test	*p* value
How many days in a week do you use turmeric powder in your recipes?	3-5 Days	28	2.2	73.984**	< 0.001
	6 Days	24	1.9		
	7 Days	1224	95.9		

(** Significant, $p < 0.001$)

Correlation between Non-communicable Diseases and Curcumin use

The Mann-Whitney U test was used to compare the amount of curcumin used according to non-communicable diseases. There was a significant difference ($p < 0.05$) in the amount of use among diabetes ($p = 0.006$) and arthritis ($p = 0.023$) patients as represented in Table 8.

Aware about Medicinal Herb

The majority of households (84.4%) aware that curcumin is a medicinal herb and only 15.6% of households use it without being aware of its medicinal properties as described in Table 9.

Patterns of Turmeric use other than Curry

Out of 1276 households, majority of them use turmeric for wounds and cuts (80.6%) followed by spiritual purpose (79.8%), women for bathing (77.1%), steam inhalation (63.7%), turmeric milk for cough (51.7%), gargling (22.2%), face creams (18.7%) and others (10.6%) such as insect repellent, first aid in poison bite as shown in Figure 1.

Knowledge about Turmeric use in Various Diseases

The knowledge of the households about turmeric in treating various diseases such as cough (65.8%), skin diseases (23.9%), throat infection (2.3%), chicken pox (2.2%), cancer (1.2%), Gastrointestinal Problems (0.9%) and Foot cracks (0.7%) through multiple responses.

Knowledge about Pharma Preparations

Out of 1276 households, the majority of the participants (91.8%) do not know about the pharmaceutical preparations of curcumin like capsules, tablets, drops, sachets, and other formulations as represented in Table 10.

Table 8: Correlation between Non-communicable diseases and curcumin use.

(*n* = 4495) Median		Yes		No		"Z"	*p* value
		IQR	Median	IQR			
Daily curcumin use divided by their family members	Cardiovascular diseases	0.50	0.25 to 0.75	0.50	0.25 to 0.75	-0.829	0.407
	Diabetes	0.50	0.33 to 0.75	0.75	0.50 to 1.00	-2.776	0.006*
	Asthma	0.33	0.25 to 0.58	0.50	0.25 to 0.75	-1.297	0.195
	Cancer	0.75	0.75 to 0.75	0.50	0.25 to 0.75	-0.969	0.333
	Alzheimer's Disease	0.25	0.13 to 0.50	0.50	0.25 to 0.75	-1.355	0.175
	Arthritis	0.50	0.38 to 0.75	0.50	0.25 to 0.75	-2.279	0.023*
	Psoriasis	0.40	0.28 to 1.00	0.50	0.25 to 0.75	-0.478	0.633
	Others	0.50	0.27 to 0.75	0.50	0.25 to 0.75	-0.894	0.371

(IQR = Inter Quartile Range; * Significant, p <0.05)

Table 9: Aware about Medicinal Herb.

(*n* = 1276)		Frequency	%	Chi square test	*p* value
Are you aware that turmeric is a medicinal herb?	Yes	1077	84.4	157.644**	< 0.001
	No	199	15.6		

(** Significant, p < 0.001)

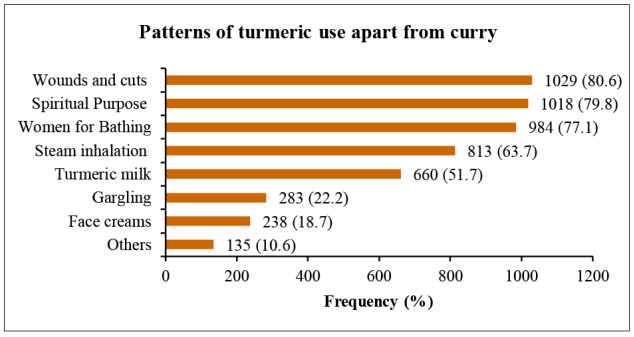

Figure 1: Patterns of Turmeric use other than curry.

Table 10: Knowledge about pharma preparations.

(*n* = 1276)		Frequency	%	Chi square test	*p* value
Did you know that turmeric powder was available as Pharmaceutical preparation like tablet, capsule?	Yes	104	8.2	259.177**	< 0.001
	No	1172	91.8		

(** Significant, p < 0.001)

Perception and Consumption of Turmeric during COVID- 19

Out of 1276 households, 66.8% of households trust that turmeric could act as preventive medicine against COVID-19 as shown in Figure 2 and only 60.4% of households use more turmeric during COVID-19 than usual as in Figure 3. While taking the survey, most of the households reported that steam inhalation, gargling and turmeric milk usage increased after the COVID-19 pandemic came.

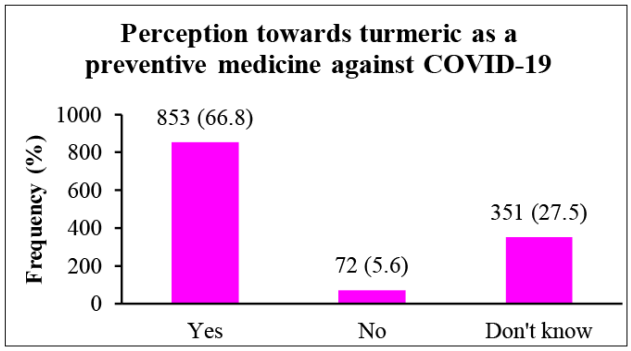

Figure 2: Perception towards turmeric as a preventive medicine against COVID-19.

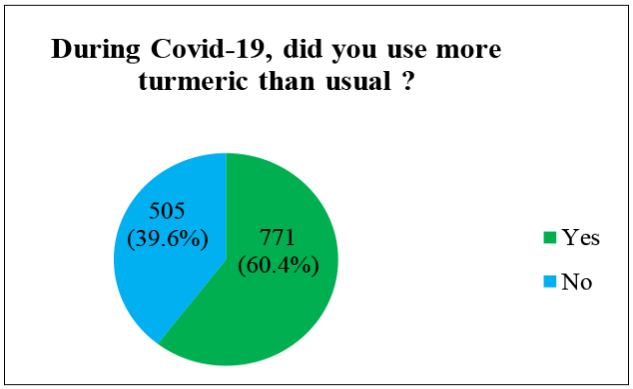

Figure 3: Excessive use of turmeric during COVID- 19.

DISCUSSION

This was the first multi-centric cross-sectional observational study investigating the prevalence of non-communicable disease and curcumin use by asking the people about their amount, duration, and

frequency of curcumin intake and then compared with their non-communicable disease status. In this study, we have dissected four different centers in the state of Tamil Nadu based on our access and also created google forms to collect the data from people during the lockdown. Actually, we got 99 responses through google forms and took only 76 fully completed responses with 300 samples each from four centers by the Kish method. Thus, 1276 households participated with their 4495 family members and most of the participants were female.

A Majority of households are in rural population (57.1%) followed by urban population (42.9%) which coincides with Mathur P *et al*.,[5] conducted a study and reported that majority of the rural population than the urban population. The majority of family members were female which is 2396 family members (53.3%) and also the study conducted by Abebe SM *et al*.[6] 2017 showed that females (50.77%) were more contributed than that of males (49.23%).

Among the households, the average years of turmeric use and average amount of curcumin in their daily recipes was asked by showing calibrated spoons to them. To avoid bias in the amount of curcumin use by the households was cross-checked by asking monthly buying quantity of turmeric powder. Then the frequency of turmeric use among the households were also been found that the majority of 7 days (95.9%) followed by 3-5 days (2.2%) and 6 days (1.9%). Thus, the average daily curcumin use in their daily recipes divided by their family members of 4495 was found to be 0.54 g along with the standard deviation of 0.38 g. By applying the Mann-Whitney U test, there was a significant difference ($p < 0.05$) in the amount of curcumin use with the prevalence of diabetes ($p = 0.006$) and arthritis ($p = 0.023$).

Our analyses revealed that the prevalence of diabetes was significantly associated with curcumin use ($p = 0.006$), which validates the concept that eating a lot of curry lowers the incidence of type 2 diabetes and the findings of earlier research (Duc H.N. *et al*.[7] and Srinivasan M *et al*.).[8] Another meta-analysis seems to confirm the benefits of curcumin on glucose metabolism, and concluded the daily supplement of curcumin could improve some metabolic aspects of uncomplicated T2DM patients. Altobelli E *et al*.[9] and Youngjoo Kwon *et al*.[10] also points out that modest curry consumption (2 to 4 times per month) is associated with lower blood glucose and TG levels, after estimates were corrected for confounding variables in overweight people with high blood lipid and glucose levels. The daily use of average curcumin of 0.50 g is also correlated with arthritis ($p = 0.023$) of which it is significant.

In our study, it was reported that the p-value of asthma is not significant ($p = 0.195$) but Tze Pin Ng *et al.,*[11] a preliminary study support the hypothesis that the dietary intake of curcumins in a turmeric-rich curry among Asians had a better effect on pulmonary function ($p = 0.05$). For Alzheimer's disease, it has a p-value of about 0.173 but Tze-Pin Ng *et al*.[12] conducted a study which reports the tentative evidence of better cognitive performance from curry consumption ($p = 0.065$) in non demented elderly Asians (particularly Indians).

The majority of the households (84.4%) aware that curcumin as a medicinal herb and only 15.6% of households using it without aware about their medicinal properties which conforms with Abinaya S *et al*.[13] conducted an online survey where 98% of the people aware about turmeric as a medicinal herb and as a herbal cure for COVID-19.

Apart from curcumin used as a curry spice, it has been historically used as a natural coloring agent (food, cosmetics, and textiles), for women for bathing, spiritual purpose, wound healing, and insect repellent, and as an antimicrobial agent. In our present study, out of 1276 households, the majority of them use turmeric for wounds and cuts (80.6%) followed by spiritual purpose (79.8%), women for bathing (77.1%), steam inhalation (63.7%), turmeric milk for cough (51.7%), gargling (22.2%), face creams (18.7%) and others (10.6%) such as insect repellent, first aid in poison bite.

Out of 1276 households, the majority of the participants (91.8%) do not know about the pharmaceutical preparations of curcumin like capsules, tablets, drops, sachets and other formulations. This highlights the pharmaceutical companies to increase their insights into marketing the curcumin supplements for the general public. On the other side in US in 2016, turmeric was the top selling herbal Dietary Supplement within the natural retailer channel for the fourth consecutive year with over $47 million in sales, an increase of 32% from the prior year.[14]

Over 66.8% of the households trust turmeric could prevent COVID-19 which is supported by Brahmbhatt *et al*.[15] that points out curcumin could have a preventive role in the COVID-19 pandemic. This is correlated with1Abinaya S *et al*.[13] conducted an online survey where 98% of the people aware about turmeric as a preventive medicine for COVID-19. About()60.4% of households use more curcumin during COVID-19 than usual. During the survey, most of the households reported that steam inhalation, gargling and turmeric milk usage are increased after COVID-19 pandemic has come. This was supported

by Ganesh Shanmugasundaram A *et al*.[16] which highlights that taking turmeric milk and using turmeric powder in the curry increases immunity during COVID-19. Similar to this, turmeric steam inhalation is one of the common home remedies for improving respiratory health by treating common colds and coughs that our bodies frequently acquire throughout the change of seasons.

CONCLUSION

The present study revealed that the prevalence of diabetes and arthritis was significantly associated with curcumin use which supports the hypothesis that the mean intake of 0.54 gm of curcumin per day reduces the risk of type 2 diabetes and arthritis. On the other side, people in India were more aware of curcumin as a medicinal herb and consumed a higher amount, particularly during the COVID-19 pandemic.

Limitations

Curcumin amount is a quantitative variable and the NCDs status is a qualitative variable, so it limits the application of Pearson/ Spearman Correlation tests. We Conducted only in 4 centers and there was a need to conduct this study in more centers with large sample size.

Future Recommendations

This study correlated the use of curcumin and NCDs only; More study is required to correlate use of curcumin with other specific diseases. Apart from curcumin, various other spices with medicinal properties are also used in Indian households. So, there is a need to conduct the study in relation to other spices.

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We declare that this work was done by the authors named in this article and all liabilities pertaining to claims relating to the content of this article will be borne by the authors. I would like to express my heartily thanks to all the participants who actively participated in this study.

CONFLICT OF INTEREST

The authors declare that there is no conflict of interest.

ABBREVIATIONS

NCD: Non-communicable Diseases; **COVID-19:** Corona Virus Disease-2019; **WHO:** World Health Organization; **SPSS:** Statistical Package for Social Sciences.

SUMMARY

Non- communicable diseases are increasing rapidly all over the world, on the other hand curcumin has various medicinal properties against NCDs and it is a major ingredient in our household/recipes. So this study included 1276 households along with their 4495 family members. Then we collected demographic details and disease status, followed by turmeric usage and their awareness status. Hence it was found out that the prevalence of diabetes and arthritis had been significantly correlated with the mean intake of 0.54 g of curcumin per day.

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