

Statistical Analysis and Mathematical Modelling for the Utilization and Efficacy of Menthol Crystals Vapor Inhalation for the Control of the Covid-19 Pandemic

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Abstract

Aim: To find out the utilization and efficacy of menthol crystal and its vapor in Jamaica since the validating clinical trial for its use in the prevention and cure of COVID-19 and by extension utilize by extrapolation and mathematical modeling the possible effect of its utilization on the hospitalization, morbidity and mortality from COVID-19.

Method: The aim of this paper is to utilize a purposefully designed questionnaire called the Menthol crystal utilization questionnaire which is to be completed by pharmacists in Montego Bay Jamaica, and to be subjected to statistical analysis so as to appreciate at a glance whether there has been an increase in the usage of menthol crystal through purchases after a clinical trial designed to validate the use of menthol as a drug or chemical substance that can prevent the acquisition of COVID-19 and that also cure the early diagnosed COVID-19.

This questionnaire-based research also looks into whether menthol crystal is a prescription drug in Jamaica or not and additionally it is designed to evaluate the complications and side effects if any following the use of menthol during the pandemic. The statistical outcome was then subjected to mathematical model for efficacy function of sale volume and the period of menthol crystal utilization for the treatment and control of COVID-19.

Conclusion: All the respondent pharmacies declared that menthol crystals are not a prescription medical substance. They all also responded that there has been an increase usage of menthol by customers, which is identified by an unusually high, though variable increase in purchase ranging from

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10-20% to 90-100. None of these respondents identified any side effect or complication following the use of menthol crystal.

Key Words; Menthol crystals, Drug, Utilization, Efficacy, Statistical analysis, Mathematical modeling.

Introduction

The global literature in medicine, dentistry, basic medical sciences and allied medical profession has echoed the devastating effect of the coronavirus called the novel COVID-19 [1-15].

Interestingly the literature is replete of the pharmacology and medical use, to include the history and background of menthol crystal for many decades and dating back to the Second World War.

This literature has also confirmed the possible effects of menthol crystal and its vapor on the living tissues through various independent experimental studies [16-30] prior to the paper published by Lakatos from Hungary during the early part of the COVID-19 pandemic that menthol crystal and COVID-19 are enemies. Unfortunately, this scientific assertion was not taken serious by peer the review evident by virtue of this important scientific information published as a letter to the editor, but fortunately cited in Pubmed [31], and was never a part of the WHO recommendations (not even to HealthCare workers) up to this time of the global impact of the Omicron variant of the Coronavirus [32].

Against the background of the literature mentioned above, Ogunsalu, Barton and coworkers [33,34] conducted the clinical trials on COVID-19 patients and non-COVID-19 patients, attending a dental clinic, including the dental health workers to validate the antagonistic relationship between the menthol crystal and its vapor and COVID-19. They found that:

1. The people that come in contact with menthol vapor are unlikely to become sick with COVI-19 (preventive role of menthol crystal vapor).
2. The patients sick with early diagnosed COVID -19 are all cured within 3-4 days of using the menthol crystal vapor in what they called the menthol crystal inhalation regimen (MCIR).
3. The use of menthol crystal vapor in a hypoxic patient was fast in the reversion of patient to the normal oxygen level [33].

This current work now validates and analyzes the efficacy and utilization of menthol crystal vapor after the work of Ogunsalu, Barton and coworkers [33,34] by way of statistical analysis of the responses to a specially designed questionnaire and also by mathematical modeling.

Materials and methods

To appreciate the utilization of menthol crystal comparatively before the pandemic initiated by the COVID-19 virus and after the announcement of the research mentioned by our team, a questionnaire entitled “The Menthol Utilization Studies Questionnaire” for pharmacies was designed (Figure 1). This questionnaire comprised of one unnumbered question in bold and nine (9) numbered questions of which only two questions (question 1 and 8), where a Yes or No answer as was also asked in the un-numbered question on the questionnaire. Although, most questions were designed to be on an observational basis; only question 1 and 3 were actually

specified as observational basis of which question number three (#3) requested a range for the percentage increase in sales. One question (question #4) was quantitative and requested calculations that may require accounting, and which will involve the release of confidential figures. This question number 4 was made optional. Question numbers 6 and 7 were direct questions of which question 7 would have no answer if question 6 had an answer that states “None”. Question number 2 and 5 required an answer of an increase or decrease. To focus on the utilization of menthol crystal and its vapor in the region of St James in Jamaica, so as to represent the utilization of menthol crystal in Jamaica, pharmacies in Montego Bay in the Parish of St James (Figure 2) were randomly selected for the distribution of the questionnaires. This Parish is noted to have the second highest cases of COVID-19 in Jamaica and to have a significant hospitalization of cases, morbidity from cases and mortality. Also, this parish has Cornwall Regional Hospital which is the second largest Hospital in Jamaica. The areas of distribution of the questionnaires are depicted by the white circles in Figure 3. A total of 25 questionnaires were distributed to

pharmacies randomly in the downtown area (RP2 and RP3), uptown area (RP4) and outskirts (RP1) of Montego Bay as shown in Figure 3. One of the researchers personally handed over the questionnaire to the pharmacist in charge of each pharmacy after a brief introduction and a request was made of the pharmacist to kindly fill the form. To avoid subjectivity, the pharmacist at the pharmacy was further instructed that the questionnaire be picked up by non-medically qualified personnel (a messenger) within 4 to 5 hours. No questionnaire was allowed to spend more than 4-5 hours before pickup. Only one questionnaire was emailed to the pharmacy after introduction and instruction on the phone. However, this questionnaire was similarly picked up within the 4-5 hours’ time frame. The responses from all questionnaires was subjected to statistical analysis to form the scientific basis for the utilization of menthol crystals and its vapor in Montego Bay, St. James Jamaica and to represent the utilization in Jamaica as a whole against the background of the numbers of COVID-19 cases which exponentially increased during the 3rd and 4th wave of COVID-19 pandemic that was introduced by the Delta and Omicron strains respectively.

Menthol Utilization Studies Questionnaire Confirm that the sales of Menthol crystals in your pharmacy is by non-prescription Is it non-prescription (Yes or No) _____ - On an observational basis, have you sold more menthol crystals during the COVID-19 pandemic than prior to the pandemic (Yes or No) _____ - Has the sales from Menthol crystals increased or decreased since _____ (Increase or Decrease) - On an observational basis, how much percentage increase in sales have you recorded (10-20), (21-30), (31-40), (41-50), (51-60), (61-70), (71-80-), (81-90), (91-100) - On a calculated or quantitative basis, how much have you sold since _____ (option not to answer). I have sold about _____grossing a total of _____JMD - In your estimate, has the cost of menthol crystal increased or decreased? (Increase or Decrease) - How many of the clients that have purchased menthol crystal from your pharmacy have returned with complication or side effect from its use. If none, indicate so in this space _____ - If Q6 above is suggestive of complications or side effects, please list them at the back of this questionnaire. - Do the clients indicate to you on the majority the reason for purchasing the menthol crystal (Yes or No)? - Do you have shortage of menthol crystals at one stage or the other during the pandemic?
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Figure 1: Showing the questionnaire that was distributed to the pharmacies in Montego Bay.



Figure 2: Map of Montego Bay, St James Jamaica.

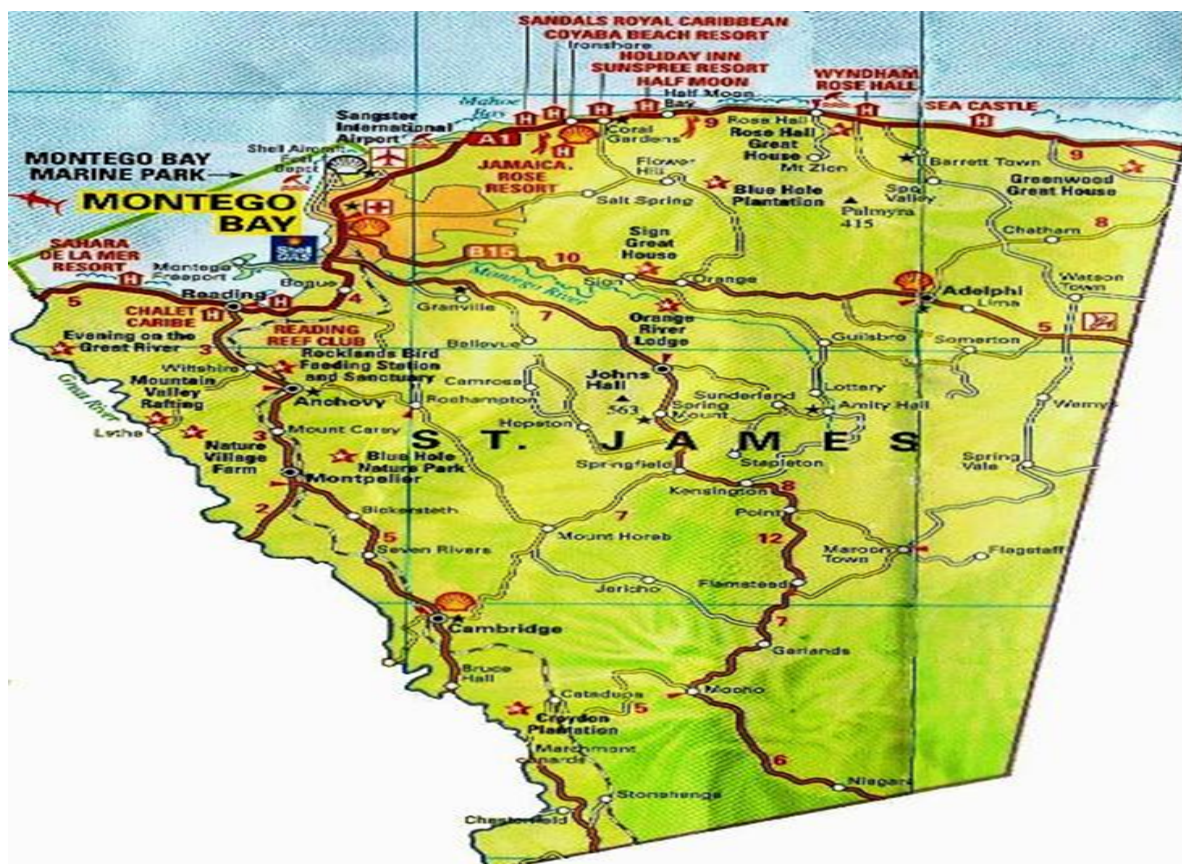


Figure 3: Showing the areas in Montego Bay that the questionnaire was distributed to, designated as RP1 to RP2.

Results

Questions	Number of Responses
Bold and un-numbered question	24 (one of the questionnaires was not returned)
Q ₁	23 Yes
	1 No
Q ₂	24
Q ₃	21 responses as follows:
	10-20%-1
	21-30%-1
	31-40%-1
	41-50%-2
	51-60%-1
	61-70%-1
	71-80%-2
	81-90%-2
	91-100%-10
Q ₄	No answer-18
	Answer as-6 which are as follows:
	1. Totally unsure
	2. Sold 1 jar@100,000JMD
	3. Sold 2900 packs@unknown cost
	4. No access to information
	5. 377 tsp since January 2021
	6. 30 bottles at 33,00 JMD
Q ₅	Increase-23
	Decrease-0
	Remain the same-1
Q ₆	No complications-24
Q ₇	0
Q ₈	Yes-13
	No-11
Q ₉	Yes-18
	No-6
	One of the yes responses indicate that the shortage was at the 3rd wave of the pandemic

Table 1: Showing the summary of the response to the questioner.

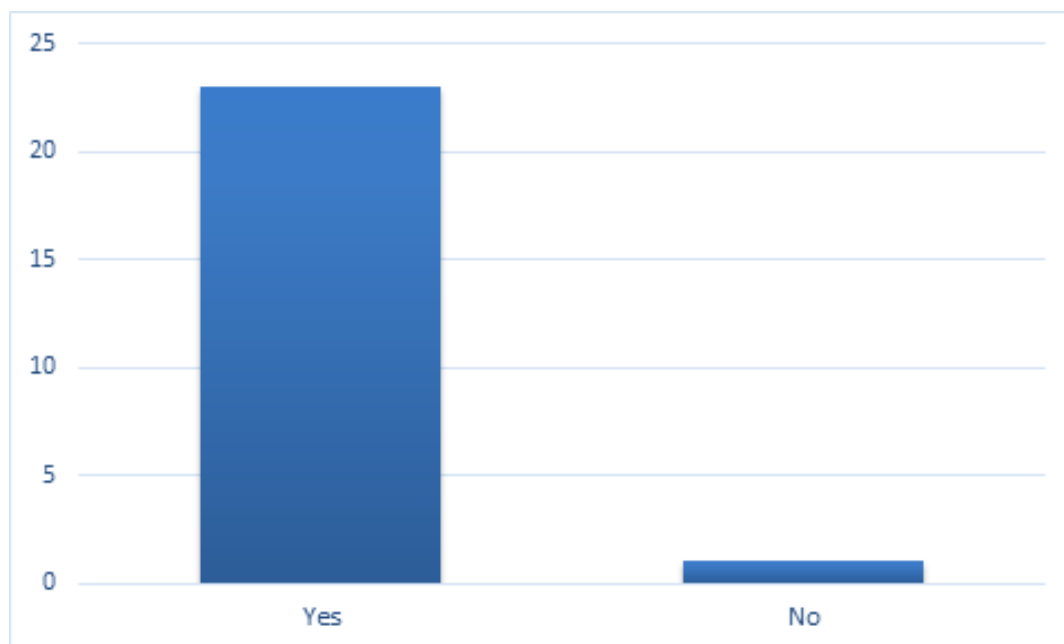


Figure 4: Showing the number of the respondents observed an increase in the sales of the menthol crystal since the beginning of the pandemic. Twenty-three (23) of the respondents stated there was an increase in sales since the pandemic while one respondent noted that there wasn't any noticeable increase in their sales since the pandemic.

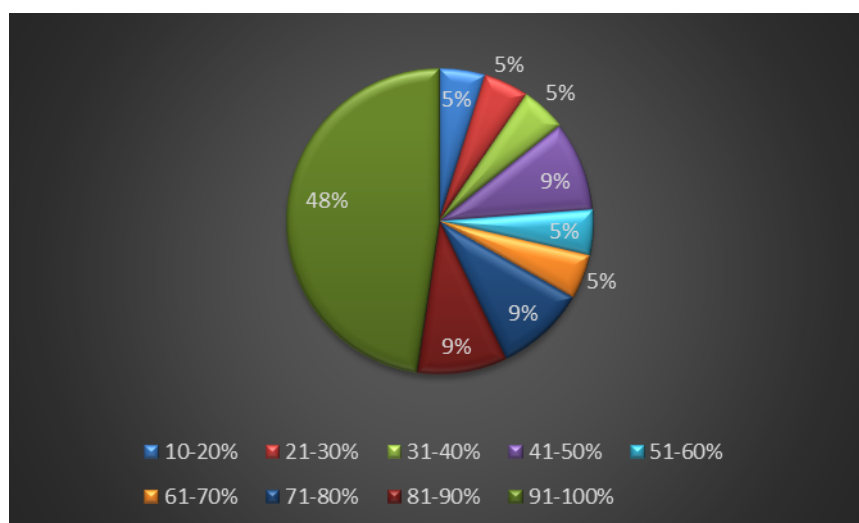


Figure 5: Showing the percentage of the observed increase in menthol crystal sales.

Figure 5 asked the respondents, on an observational level, to select what level of increase in menthol crystal sales they have recorded since the beginning of the pandemic. Forty-eight percent (48%) of the respondents stated that they observed a 91-100 % increase in sales. Nine percent (9%) stated they saw an (81-90%) increase, nine percent (9%) stated they saw a (71-80%) increase, Five percent (5%) stated they saw a (61-70%) increase, five percent (5%) stated they saw a (51-60%) increase, Nine percent (9%) stated they saw a (41-50%) increase, five percent (5%) stated they saw a (31-40%) increase, five percent (5%) stated they saw a (21-30%) increase,

five percent (5%) stated they saw a (11-20%) increase, five percent (5%) stated they saw a (1-10%) increase.

Number of Respondents	Responses
18	No answer
1	Totally unsure
1	Sold 1 jar@100,000JMD
1	Sold 2900 packs@unknown cost
1	No access to information
1	377 tsp since January 2021
1	30 bottles at 33,00 JMD

Table 2: Respondent's quantitative increase in menthol crystal sales.

Table 2 summarizes the response to question number 4 (#4), which asked the respondents to calculate or quantify the level of sales they reported for menthol crystal since the pandemic. Of the 24 questionnaires issued, only 6 respondents gave a response to this question. One respondent stated they sold one jar of menthol crystal for 100,000 JMD, another stated they sold two thousand nine hundred (2900) packs of menthol crystal but could not disclose the price at which the packs were sold. Another respondent stated they sold thirty (30) bottles of menthol crystals at 33,000 JMD each, another stated that they sold three hundred and seventy-seven teaspoons of menthol crystals. The other two respondents to this question stated that they were unable to answer the question or had no access to the data.

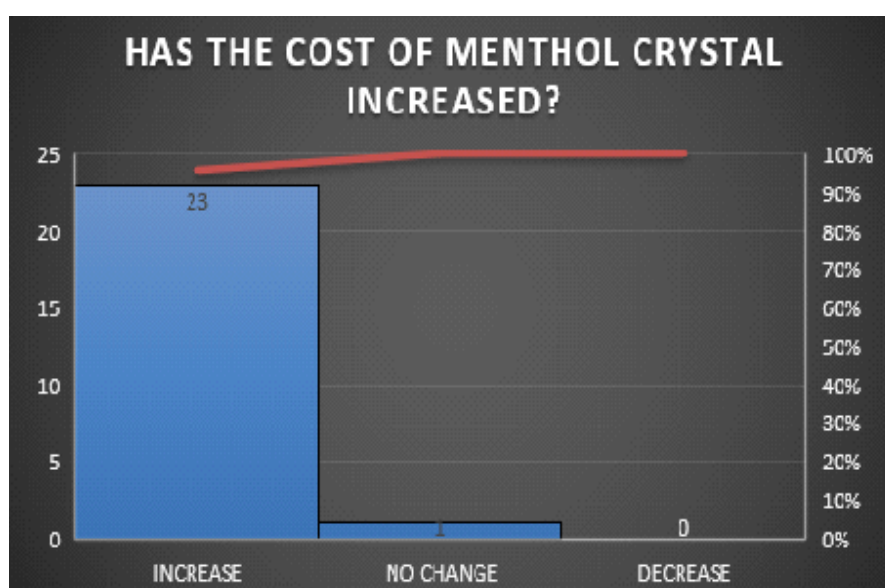


Figure 6: Summarizing the response to question number five (#5).

Question 5 asked the respondents to comment on whether the price of menthol crystals had increased or decreased since the release of the outcome of our research. As it relates to this question, ninety-six percent (96%) of the respondents stated that they saw an increase in prices. The other four percent (4%) stated that they saw no changes in the price since the outcome of the research on menthol crystal and COVID-19 was made available to the public.

Discussion

Data Analysis

The researcher designed a questionnaire called the menthol utilization questionnaire which was completed by pharmacists in Montego Bay Jamaica. The questionnaire consists of nine numbered questions and one unnumbered question which were both open and closed ended question.

The first numbered question asked the respondents whether they observed increases in the sales of menthol crystal since the beginning of the pandemic. Twenty-three (23) of the respondents stated there was an increase in sales since the pandemic while one respondent noted that there wasn't any noticeable increase in their sales since the pandemic as seen in Figure 1 and 3. This can be backed up by the following question where one hundred percent (100%) of the respondents stated they saw an increase in sale of methanol crystals since the beginning of the pandemic, with forty-eight percent (48%) stating that they experienced a (91-100%) increase in menthol crystals sales shown in figure 3.

We noted that due to these increases in sales and demand for menthol crystals there has been a shortage in supply for menthol crystals at one point or the other during the pandemic. This can be seen where seventy-five percent (75%) of the respondents stated that there was indeed a shortage, with one respondent stating that their pharmacy experienced this shortage, especially during

the third wave of the pandemic. Ninety- six percent (96%) of the respondents stated that there was an increase in the prices during the pandemic as the demand for menthol crystal increased.

To ensure the safety of the individuals purchasing the menthol crystals at this time of the pandemic for the purpose of cure and prevention of COVID-19 we introduced question number 6, which asked if any of the purchasers of menthol crystals have returned to the pharmacy with any complications or side effect. Fortunately, in support of the original perception of menthol crystals as a safe to use non-prescription drug, one hundred percent (100%) of the respondents stated that there was no complications or complaints found after purchasing menthol crystals from their pharmacy. It is for this reason that none of the respondents had to answer question number 7. This can be tied to the increases in sales which seem to validate the use of menthol as a drug or chemical substance that can prevent the acquiring the COVID-19 infection and that can cure the early diagnosed COVID-19.

The use of numerous mathematical structures such as graphs, equations, diagram, scatter plots tree diagram and other complex means not unrelated to or that can be integrated into even artificial intelligence (AI) is called mathematical modeling. Mathematical modeling is aimed at representing the real situation of things and as such we are looking at an abstraction that simplifies the problem to its essential

characteristics. Mathematical modeling in some situations can extend to solving the problem, rather than just simplifying it. This art of translating problems from an application area into tractable mathematical formulations and numerical analysis surely provides insight and answers which are useful for the originating applications.

Mathematical modeling has been used in COVID-19 from the inception of the pandemic with most directed at prediction the effect of the lockdown and isolation on the transmission of the disease, amidst of the dearth of treatment and vaccination to limit the disease at that time [35][36]. It continues to be used and surely it can bring about solution. This is why, in this chapter we are aiming to see if mathematical modeling can be used to solve the problem of ascertaining both the regional and global utilization of the menthol crystals based the identification of some possible increase in the sales from the pharmacies against the background of both regional and global decline of the spread of the viral infections twined with the very low morbidity and mortality in areas of high utilization of menthol crystal and its vapor.

Because mathematical modeling:

1. Is indispensable in many applications.
2. Is successful in many functional application.
3. Gives precision and directions for problem solving.
4. Enables understanding of the system that is modeled.
5. Prepare the way for better control of a system.

6. Allows the efficient use of modern computing capabilities.

It is not only review the current literature very briefly on utilization of mathematical modeling in COVID-19, but we will specifically utilize it to analyze the utilization of the menthol crystals both regionally and globally against the background of increase or decrease in the cases of COVID-19 and the related low morbidity and mortality of the infection as a whole since the results of our Clinical trial on the use of menthol crystal and its vapor both regionally and globally against the background of increase or decrease in the cases of COVID 19 and the related low morbidity and mortality of the infection as a whole, since the result if our clinical trial on the use of both the menthol crystal inhalation regimen (MCIR) and the mentholated environment were released to the news media as a possible treatment for early diagnosed COVID-19 and prevention of COVID 19 respectively.

As such we can further affirm that mathematical modeling is a conceptualized interpretation or representation of what is happening and a prediction of what is expected to happen in future.

Mathematical modeling of COVID-19 as discussed in the classical paper by Hyun Mo Yang [36] [37] on the transmission of the SARS-CoV2 and the evaluation of the impact of the isolation in SauPaulo state (in Brazil) and the lockdown in Spain associated with the protective measures on the epidemic of COVID 19. In their write up, we can find the derivation and expression of the following mathematical equation, which was adopted as part of their material and methods:

“Therefore, the reduced model has the equations for susceptible individuals.

$$\begin{cases} \frac{d}{dt}S_y &= \phi N - (\varphi + \mu)S_y - \lambda S_y - k_y S_y \delta(t - \tau_y^{is}) \\ \frac{d}{dt}S_o &= \varphi S_y - \mu S_o - \lambda \psi S_o - k_o S_o \delta(t - \tau_o^{is}), \end{cases} \quad (1)$$

For isolated and infectious individuals,

$$\begin{cases} \frac{d}{dt}Q_{1j} &= k_j S_j \delta(t - \tau_j^{is}) - \mu Q_j \\ \frac{d}{dt}E_j &= \lambda(\delta_{jy} + \psi \delta_{jo})S_j - (\sigma_j + \mu)E_j \\ \frac{d}{dt}A_j &= l_j \sigma_j E_j - (\gamma_j + \mu)A_j \\ \frac{d}{dt}D_{1j} &= (1 - p_j)\sigma_j E_j - (\gamma_{1j} + \mu)D_{1j} \\ \frac{d}{dt}Q_{2j} &= (1 - \chi_j)\gamma_j A_j + m_j \gamma_{1j} D_{1j} - (\gamma_{3j} + \mu)Q_{2j} \\ \frac{d}{dt}D_{2j} &= (1 - k_j)\gamma_{1j} D_{1j} - (\gamma_{2j} + \mu + \alpha_j)D_{2j}, \end{cases} \quad (2)$$

and for recovered individuals,

$$\frac{d}{dt}I = \gamma_y \gamma_y A_y + \gamma_{3y} D_{1y} + \gamma_{2y} D_{2y} + \gamma_o \gamma_o A_o + \gamma_{3o} D_{1o} + \gamma_{2o} D_{2o} - \mu I, \quad (3)$$

with $j=y,o$

where $N_j = S_j + E_j + A_j + D_{1j} + Q_{2j} + D_{2j}$, and $N = N_y + N_o + I$ obey Eq (A.5) in S1 Appendix. The force of infection λ is given by Eq (A.1) in S1 Appendix.

The system of non-autonomous and non-linear differential Eqs (1–3) is simulated permitting pulse intervention to the boundary conditions. Hence, the equations for susceptible and isolated persons

$$\begin{cases} \frac{d}{dt}S_y &= \phi N - (\varphi + \mu)S_y - \lambda S_y \\ \frac{d}{dt}S_o &= \varphi S_y - \mu S_o - \lambda \psi S_o \\ \frac{d}{dt}Q_j &= -\mu Q_j, \end{cases} \quad \text{become} \quad (4)$$

$j=y,o$, and other equations are the same. Hence, for

the system of Eqs (1–3), the initial conditions (at $t=0$) are, for $j=y, o$,

$$S_j(0) = N_{0j}, \quad X_j(0) = n_{X_j}, \quad \text{where} \quad X_j = Q_j, E_j, A_j, D_{1j}, Q_{2j}, D_{2j}, I, \quad (5)$$

Where N_y and N_o are the size of young and elder subpopulations with $N(o) = N_o = N_y + N_o$, and is a non-negative number.

For instance, $n_{E_y} = n_{E_o} = 0$ means that there is not any exposed person (young and elder) at the beginning of the epidemic.

The boundary conditions describing the quarantine implemented at $t=\tau^{is}$ are

$$S_j(\tau^{is+}) = S_j(\tau^{is-})(1 - k_j) \quad \text{and} \quad Q_j(\tau^{is+}) = Q_j(\tau^{is-}) + S_j(\tau^{is-})k_j, \quad (6) \text{ plus} \\ X_j(\tau^{is+}) = X_j(\tau^{is-}), \quad \text{where} \quad X_j = E_j, A_j, D_{1j}, Q_{2j}, D_{2j}, I, \quad (7)$$

where it has $\tau^{is-} = \lim_{t \rightarrow \tau^{is}} t$ (for $t < \tau^{is}$), and $\tau^{is+} = \lim_{t \leftarrow \tau^{is}} t$ (for $t > \tau^{is}$). If quarantine is applied to a completely susceptible population at $t=0$, there are not any infectious persons, so $S(0) = N_0$. If quarantine is done at without a screening of persons harboring the virus, then many of the asymptomatic persons could be isolated with susceptible persons.

The epidemiological scenario of quarantine is obtained by the solution of the system of Eqs (1–3). The simulation of this system provides the epidemic curve (severe CoViD-19 cases D_2), and the numbers of susceptible (S) and recovered (I) persons. However, the following epidemiological parameters (the initial conditions (5) supplied to the system of equations determine all initial conditions below) are derived:

1. The number of non-isolated (circulating) persons S_j is obtained from Eq (4), and the number of circulating plus isolated susceptible persons S_{tot} is obtained by

$$S^{tot} = S_y^{tot} + S_o^{tot}, \quad \text{with} \quad \begin{cases} S_y^{tot} = S_y + Q_y \\ S_o^{tot} = S_o + Q_o, \end{cases} \quad (8) \text{ where } S_y^{tot} \text{ and } S_o^{tot} \text{ are the numbers} \\ \text{of susceptible, respectively, young and elder persons.}$$

$$\begin{cases} \frac{d}{dt} \Phi_y = \lambda S_y \\ \frac{d}{dt} \Phi_o = \lambda \psi S_o, \end{cases} \quad \text{with} \quad \Phi = \Phi_y + \Phi_o, \quad (9)$$

2. The numbers of new cases of CoViD-19 Φ_y and Φ_o are where $\Phi_y(0) = E_y(0)$ and $\Phi_o(0) = E_o(0)$.
3. The numbers of accumulated severe CoViD-19 cases Ω_y and Ω_o are given by the exits from D_{1y} , Q_{1y} , D_{1o} , and Q_{1o} , and entering into classes D_{2y} and D_{2o} , that is,

$$\begin{cases} \frac{d}{dt} \Omega_y = (1 - m_y) \gamma_{1y} (D_{1y} + Q_{1y}) \\ \frac{d}{dt} \Omega_o = (1 - m_o) \gamma_{1o} (D_{1o} + Q_{1o}), \end{cases} \quad \text{with} \quad \Omega = \Omega_y + \Omega_o, \quad (10)$$

with $\Omega_y(0) = \Omega_{y0}$ and $\Omega_o(0) = \Omega_{o0}$. The daily severe CoViD-19 cases Ω_d is, considering $\Delta t = t_i - t_{i-1} = \Delta t = 1$ day,

$$\Omega_d(t_i) = \int_{t_{i-1}}^{t_i} \frac{d}{dt} \Omega dt = \Omega(t_i) - \Omega(t_{i-1}), \quad (11)$$

where $\Omega_d(0)=\Omega_{d0}$ is the first observed CoViD-19 case at $t_0=0$, with $i=1, 2, \dots$, and $t_i=1$ is the next day in the calendar time, and so on.

4. The number of deaths due to severe CoViD-19 cases is

$$\Pi = \Pi_y + \Pi_o, \quad \text{where} \quad \begin{cases} \frac{d}{dt}\Pi_y = \alpha_y D_{2y}, & \text{with } \Pi_y(0) = 0 \\ \frac{d}{dt}\Pi_o = \alpha_o D_{2o}, & \text{with } \Pi_o(0) = 0. \end{cases} \quad (12)$$

In the estimation of the additional mortality rates, we must bear in mind that the registration times of the new cases and deaths do not have direct correspondence, somewhat they are delayed by Δ days, that is, $\Pi_y(t+\Delta)=\alpha_y D_{2y}(t)$, for instance. We can estimate the severity case fatality rate as the quotient Π/Ω , and the infection fatality rate as Π/Φ .

Mathematical model for efficacy function of Sale volume and time of menthol crystals utilization for covid-19 treatment/control

Many mathematical models both for efficacy and attrition assessments are in the literature [37,38] as well as models for oncology drugs achievement in the market [38,39]. However, it is not known to us that a mathematical model for the overall safety use of drug, particularly the COVID-19

treatment/control using menthol crystals vapor can be found in the literature till this model which is hinged on the sale volume over time of menthol crystal that had been clinically validated by Ogunsalu, Barton and coworkers [33,34] in the West indies recently.

Definitions

1. Efficacy of menthol crystals vapor is denoted by E_m
2. Sale volume of menthol Crystals by pharmaceutical outlets is denoted by S_m
3. Sale volume of menthol crystals is time dependent.
4. The volume of sale of menthol crystals before the positive results of clinical tails of the menthol crystal for treatment/control of covid-19 is (S_o, t_o) .

Assumptions

A1 Efficacy of drug after clinical trials ratification (in this case menthol crystals vapor for treatment/control of covid-19) depends on the sale volume of menthol crystals since the pandemic.

A2 Sale volume of menthol crystals before the Covid-19 pandemic is $S_{m0}=S_m(t_0)$

A3 Time variable is non-negative, $t>0$.

A4 All extraneous variables are kept constant.

A5 After the clinical satisfaction by Ogunsalu et. al., the sale volume of menthol crystals is $S_m=S_m(t)$, $t \geq t_0$.

Mathematical formulation

From the assumptions this model defined efficacy of menthol crystals vapor for the treatment/control of covid-19 as a function of two variables in calculus parlance, given by

$$E_m = E_m(S_m, t) . \quad (M1)$$

The total differential of (1) gives.

$$dE_m = (\partial E_m / (\partial S_m)) dS_m + (\partial E_m / \partial t) dt . \quad (M2)$$

At (S_o, t_o) , $(\partial E_m / (\partial S_m)) = (\partial E_m / \partial t) = 0$ is a necessary condition for establishing critical region of efficacy of menthol crystals. Using the sale volume increase of menthol crystals by pharmaceutical outlets before the covid-19 pandemic as indicator for its efficacy the following formation suffice it. Let us utilize Taylor expansion about the (S_o, t_o) , with $\Delta S_m = (S_m - S_o)$, $\Delta t = (t - t_o)$, we have

$$E_m(S_m, t) = E_m(S_o, t_o) + (\partial E_m / (\partial S_m)) \Delta S_m + (\partial E_m / \partial t) \Delta t + 1/2! [(\partial^2 E_m / (\partial S_m^2)) (\Delta S_m)^2 + 2 (\partial^2 E_m / (\partial S_m \partial t)) (\Delta S_m \Delta t) + (\partial^2 E_m / (\partial t^2)) (\Delta t)^2] + \dots \quad (M3)$$

with all derivatives to be evaluated at (S_o, t_o) .

To establish sufficient conditions for whether there is indication of growth in in sale volume of menthol crystals as consequence its efficacy we note that.

$$(\partial E_m / (\partial S_m)) \Delta S_m + (\partial E_m / \partial t) \Delta t = (\Delta S_m \partial / (\partial S_m) + \Delta t \partial / \partial t) E_m , \quad (M4)$$

and

$$1/2! [(\partial^2 E_m / (\partial S_m^2)) (\Delta S_m)^2 + 2 (\partial^2 E_m / (\partial S_m \partial t)) (\Delta S_m \Delta t) + (\partial^2 E_m / (\partial t^2)) (\Delta t)^2] = 1/2! (\Delta S_m \partial / (\partial S_m) + \Delta t \partial / \partial t)^2 E_m . \quad (M5)$$

From (3) we obtain

$$E_m(S_m, t) - E_m(S_o, t_o) \sim 1/2! [(\Delta S_m)^2 (\partial^2 E_m / (\partial S_m^2)) + 2(\Delta S_m \Delta t) (\partial^2 E_m / (\partial S_m \partial t)) + (\Delta t)^2 (\partial^2 E_m / (\partial t^2))] \quad (M6)$$

$$\sim 1/2! [(\partial^2 E_m / (\partial S_m^2)) (\Delta S_m + ((\partial^2 E_m / (\partial S_m \partial t)) / ((\partial^2 E_m / (\partial S_m^2))))^2 + (\Delta t)^2 ((\partial^2 E_m / (\partial t^2)) - ((\partial^2 E_m / (\partial S_m \partial t))^2 / ((\partial^2 E_m / (\partial S_m^2)))))] . \quad (M7)$$

Let

$(\partial^2 E_m / (\partial S_m^2)) = E_{ss}$, $(\partial^2 E_m / (\partial S_m \partial t)) = E_{st}$, $(\partial^2 E_m / (\partial t^2)) = E_{tt}$, and equation (7) is required to be positive for all values of ΔS_m , Δt ; hence sufficiency condition requires

$$E_{ss} > 0 \text{ and } E_{ss} E_{tt} > (E_{st})^2 , \quad (M8)$$

for the critical region of efficacy to be a maximum region at (S_o, t_o) .

Similarly equation (7) is required to be negative for all values of ΔS_m , Δt when

$$E_{ss} < 0 \text{ and } E_{ss} E_{tt} < (E_{st})^2 , \quad (M9)$$

for the critical region of efficacy to be a maximum region at (S_0, t_0) .

Interpretations

Equation (M8) indicates that there is a growth in sales of menthol crystals by the pharmaceutical sale outlets due to its utilization for treatment/control of covid-19 after the announcement by Ogunsalu et. al [33,34].

Equation (M9) could be interpreted to mean otherwise of the equation (M8) interpretation. But this does not support the statistics of sale of menthol crystal in the studied region of Jamaica, which consistently shown huge increase in sales after the clinical trials of menthol crystals vapor for treatment/control of Covid-19 patient announcement by Ogunsalu team in the Caribbean hemisphere.

Conclusion

Following our clinical study on the use of MCIR and also the occasional single use of menthol crystal vapor in the treatment of early diagnosed COVID-19 and prevention respectively, we have confirmed through statistical analysis that the use of menthol crystals as confirmed by the respondents to our questionnaires can be correlated directly to the decrease in the hospitalization of patients with COVID-19, decrease in the number of covid-19, together with the decrease in the morbidity and mortality as a result of utilization of menthol crystals for treatment/control of COVID-19. This findings which have now been subjected to mathematical modeling for the efficacy function of the sales volume and utilization of menthol crystal in the treatment and control of COVID-19 was able to derive a mathematical equation that there is a growth in the sales of menthol crystals by the pharmaceutical sales outlets

due to increased utilization for both the prevention of COVID-19 and cure of the early diagnosed COVID-19, following the validation by the clinical trial of Ogunsalu et al.

The data obtained from our study shows that the MCIR when used alone out of the Hospital under the personal supervision of a clinician shortens the time of recovery of early diagnosed elderly and middle-aged patients. In both categories of patients, total remission of symptoms was documented together with the reversion of all patients from a COVID 19 positive status to a negative status when used for a period of two to five days. The use of menthol crystal inhalation in the instantaneous relief of hypoxia has also been confirmed in this study. Finally, the described mentholated environment has proved to be reliable in the prevention of the COVID 19 infection in both the patients and dental healthcare workers in this current study.

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Disclosure

The research team and authors do not have any financial interest in menthol crystals, or the aroma dispenser and the mentholated face shields described for professional use during this period of pandemic. The research work has been sponsored solely by

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Conflict of Interest

The authors report no conflict of interest in this work.

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