

# Noncommunicable diseases and changes in lifestyles during the COVID-19 pandemic in Brazil

## *Doenças crônicas não transmissíveis e mudanças nos estilos de vida durante a pandemia de COVID-19 no Brasil*

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**ABSTRACT:** *Objective:* To compare lifestyle changes during the COVID-19 pandemic according to the presence or absence of noncommunicable diseases (NCDs) in Brazilian adults. *Methods:* Cross-sectional study, using data from the ConVid survey, between April and May 2020. The following variables were evaluated: lifestyle and presence of one or more NCDs (diabetes, hypertension, respiratory disease, heart disease, and cancer). Sociodemographic characteristics were used as adjustment. Relative frequencies and confidence intervals (CI) of 95% of the explanatory variables were calculated before and during the pandemic. For the comparison of groups, with or without NCDs, crude and adjusted (PRadj) prevalence ratios were estimated by Poisson regression. *Results:* There was a reduction in physical activity (60% in those without NCDs and 58% in those with NCDs) and in vegetable consumption (10.8% in those without NCDs and 12.7% in those with NCDs). On the other hand, there was an increase in the time spent watching television and on screens of computer/tablet (302% and 43.5% in those without NCDs and 196.5% and 30.6% with NCDs, respectively); consumption of frozen meals (43.6% in those without NCDs and 53.7% with NCDs), snacks (42.3% without NCDs and 31.2% with NCDs), and chocolate (14.8% without NCDs). During the pandemic, patients with NCDs were less active (PRadj = 0.77; 95%CI 0.65 – 0.92), had greater habit of watching TV (PRadj = 1.16; 95%CI 1.08 – 1.26), and consumed less vegetables (PRadj = 0.88; 95%CI 0.81 – 0.96). *Conclusion:* It was evident that adults with NCDs had their lifestyles more altered during the COVID-19 pandemic.

**Keywords:** Quarantine. Coronavirus. Lifestyle. Risk factors. Noncommunicable diseases. Brazil

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**RESUMO:** *Objetivo:* Comparar as mudanças de estilos de vida durante a pandemia COVID-19, segundo a presença ou não de doenças crônicas não transmissíveis (DCNT) em adultos brasileiros. *Métodos:* Estudo transversal, com dados da pesquisa ConVid — Pesquisa de Comportamentos, realizada entre abril e maio de 2020. Avaliaram-se as variáveis estilo de vida e presença de uma ou mais DCNT (diabetes, hipertensão, doença respiratória, doença do coração e câncer). As características sociodemográficas foram usadas como ajuste. Calcularam-se as frequências relativas e os intervalos de confiança (IC) de 95% das variáveis antes da e durante a pandemia. Para a comparação de grupos, sem ou com DCNT, estimaram-se as prevalências e razões de prevalência bruta e ajustada (RPa) utilizando a regressão de Poisson. *Resultados:* Houve redução da prática de atividade física (60% nos sem DCNT e 58% nos com DCNT) e do consumo de hortaliças (10,8% nos sem DCNT e 12,7% nos com DCNT). Verificou-se aumento no tempo de uso de televisão e computador/tablet (302 e 43,5% nos sem DCNT e 196,5 e 30,6% nos com DCNT, respectivamente); consumo de congelados (43,6% nos sem DCNT e 53,7% com DCNT), salgadinhos (42,3% sem DCNT e 31,2% com DCNT) e chocolate (14,8% sem DCNT). Durante a pandemia, portadores de DCNT apresentaram menor prática de atividade física suficiente (RPa = 0,77; IC95% 0,65 – 0,92), maior hábito de assistir à televisão (RPa = 1,16; IC95% 1,08 – 1,26) e menor consumo de hortaliças (RPa = 0,88; IC95% 0,81 – 0,96). *Conclusão:* Evidenciou-se que adultos com DCNT tiveram seus estilos de vida mais alterados durante a pandemia de COVID-19.

*Palavras-chave:* Quarentena. Coronavírus. Estilo de vida. Fatores de risco. Doenças não transmissíveis. Brasil.

## INTRODUCTION

Globally, it is estimated that noncommunicable diseases (NCDs) are responsible for 41 million deaths (70% of all deaths) per year<sup>1</sup>. In Brazil, the high burden of NCDs is similar, corresponding to 76% of the causes of death<sup>2</sup>. NCDs result in devastating consequences for individuals, families, and communities in addition to overloading healthcare systems<sup>1,3,4</sup>.

Several national and global initiatives have been proposed for the prevention and control of NCDs. The United Nations has included goals for the reduction of NCDs and risk factors by 2030 in the Sustainable Development Goals (SDGs)<sup>5</sup>. It should be noted that this commitment was already challenging and, considering the pandemic of the new coronavirus (Sars-CoV-2), such goal may not be achieved<sup>6</sup>, as the pandemic can affect lifestyles and compromise the health care of people with NCDs<sup>7</sup>.

NCDs are the main comorbidities of patients with COVID-19<sup>7-9</sup>, being responsible for the worsening of the clinical condition and for the increase in hospital stay and mortality rates<sup>10,11</sup>. Furthermore, social distancing measures have a potential impact on the health and quality of life of people with NCDs<sup>6</sup>, although they are essential to reduce the spread of the virus<sup>12,13</sup>.

Studies carried out in Brazil<sup>14</sup> and in other countries<sup>15-18</sup> observed changes in adults' lifestyles as a result of the COVID-19 pandemic such as increased consumption of alcohol and tobacco<sup>17</sup> and ultra-processed foods<sup>14</sup> and sedentary behavior<sup>14,16</sup>. Anxiogenic and stressful

situations, such as job loss, unsafe work situations, and reduced income, can worsen health behaviors such as increased consumption of tobacco and alcohol<sup>15-18</sup>.

Within the context of NCDs, in view of the high burden and transcendence of chronic conditions, the scenario imposed by the COVID-19 pandemic reinforces the importance in prioritizing a comprehensive approach to the population's health, of disease surveillance and care actions during and after the pandemic<sup>18</sup>. The health crisis caused changes in the forms of care in the health system<sup>19</sup>, which culminated in lack of medication, difficulties in accessing services<sup>19-21</sup> and increase in risk factors for NCDs<sup>14</sup>.

Therefore, considering the need to monitor the health status and behaviors of patients with NCDs, especially in the context of the COVID-19 pandemic, it is relevant to investigate whether changes in lifestyle have occurred among this population, as there are scarce studies addressing this topic in the Brazilian context. Thus, this investigation aimed to compare lifestyle changes in Brazilian adults during the COVID-19 pandemic, according to the presence or absence of NCDs.

## METHODS

This is a cross-sectional study, which used data from *ConVid – Pesquisa de Comportamentos* (Behavior Survey), a virtual health survey carried out during the COVID-19 pandemic to assess changes that have occurred in the lives of Brazilian adults<sup>22</sup>. The questionnaire<sup>22</sup> addressed sociodemographic characteristics, adherence to measures of social restriction, economic losses, chronic diseases, changes in lifestyles and mood, among other topics.

Data collection was carried out between April and May 2020. Participants were invited to participate in the research through a chain sampling process<sup>23</sup>. In the first stage, the involved researchers chose a total of 200 other researchers from different states in Brazil and, additionally, each one of them selected 20 people from their respective social networks. People chosen in the first stage invited at least 12 people from their own social networks, following the stratification by sex, age group (18–39; 40–59; ≥ 60 years) and education level (some high school or less; high school or more). Each guest was asked to invite at least three other people from their social networks. With this process, the final sample consisted of 45,160 individuals. Post-stratification weights were used based on data from the National Household Sample Survey (PNAD) – 2019<sup>24,25</sup> to obtain the same distribution of the Brazilian population per Federation Unit, sex, age group, ethnicity/skin color, and education level.

The study is a partnership between researchers from Fundação Oswaldo Cruz, Universidade Federal de Minas Gerais, and Universidade Estadual de Campinas. Participants filled out the informed consent form and all responses were anonymous. The research was approved by the National Research Ethics Committee (opinion number: 3.980.277).

In this study, the variable “having one or more NCDs” was assessed by the question: “Has any doctor ever diagnosed you with any of these diseases (diabetes, hypertension, respiratory disease, heart disease, cancer)?”

The following variables, related to lifestyle before and during the pandemic, were analyzed.

- Physical activity (PA), assessed by the following questions: “Before the pandemic, how many days a week did you do any type of physical exercise or sport?”; “During the pandemic, how many days a week have you been doing/ did you do physical exercise or sport?” The answers to these questions were: a) less than one day a week; b) one to two days; c) three to four days; and d) five or more days. “Before the pandemic, how long did this activity last?”; “During the pandemic, how long has this activity been lasting/ did this activity last?” The response options were: a) less than 30 minutes; b) 30 to 45 minutes; c) 46 to 60 minutes; and d) an hour or more. Individuals who reported at least 150 minutes of PA per week were considered sufficiently active<sup>26</sup>.
- Sedentary behavior was assessed by time spent watching television and on screens of computer/tablet. As for the time spent watching television, the questions were: “Before the pandemic, how many hours a day did you watch television?”; “During the pandemic, how many hours a day have you been watching/ did you watch television?” The answer options were: a) did not watch television; b) less than 1 hour; c) between 1 hour and less than 2 hours; d) between 2 hours and less than 3 hours; e) between 3 hours and less than 4 hours; f) between 4 hours and less than 5 hours; g) between 5 hours and less than 6 hours; and h) 6 hours or more. For computer/tablet use, the questions were: “Before the pandemic, how many hours a day did you use to use a computer or tablet?”; “During the pandemic, how many hours a day have you been using your computer or tablet?” This was an open-ended question, and the respondent indicated the number in hours. Both indicators were classified using the cut-off point of 4 hours/day<sup>27</sup>.
- Consumption of healthy (greens or vegetables, fruits and beans) and unhealthy foods (frozen pizza or frozen lasagna or other frozen meals; packaged snacks; processed meats chocolates and sweets) were assessed by indicating the consumption of these foods according to the following question: “Usually, before the pandemic, how many days a week did you use to eat these foods?” and “During the pandemic, how many days a week have you been eating/ did you use to eat these foods?” The response options were: a) five days or more; b) two to four days; c) one day or less. For healthy foods, consumption on five or more days a week was considered adequate<sup>28</sup>. For unhealthy foods, the frequency of two or more days a week was considered inadequate, as the consumption of these foods is not indiscriminately recommended<sup>29</sup>;
- Increased consumption of alcoholic beverages was analyzed by the question: “During the pandemic, how have you been consuming/ did you consume alcoholic beverages?” The response options were: a) I continued drinking with the same frequency as before; b) I am drinking more; c) I am drinking less; and d) I had stopped drinking, but I started again. The alternatives “b” and “d” were considered as an increase in the consumption of alcoholic beverages, and “a” and “c” were categorized as “no increase.”
- Increase in cigarette consumption was assessed by the questions: “Are you a smoker?” and, if so: “Before the pandemic, on average, how many cigarettes did you use to

smoke per day?” and “During the pandemic, on average, how many cigarettes have you been smoking/did you smoke per day?” The answer options were: a) I did not smoke cigarettes; b) less than one per day; c) one to nine cigarettes; d) 10 to 19 cigarettes; e) 20 to 29 cigarettes; f) 30 to 39 cigarettes; g) 40 or more cigarettes. To assess the number of cigarettes, the midpoint of the response category was used and the difference between the two moments was calculated. The positive difference was considered an increase in cigarette consumption.

Initially, a descriptive analysis of the lifestyle variables was performed before and during the pandemic by calculating relative frequencies and 95% confidence intervals (95%CI), followed by the calculation of the percentage of behavioral change during the pandemic. Statistically significant differences were identified by the non-overlapping of the 95%CI of the prevalence values in question.

The two population groups (those with one or more NCDs and those without NCDs) were also compared in relation to lifestyles during the pandemic by calculating the prevalence and the crude and adjusted prevalence ratio (PR) by sex (men and women), age group (18 to 39; 40 to 59;  $\geq 60$  years), and education level (elementary school or less; high school; higher education or more), and respective 95%CI.

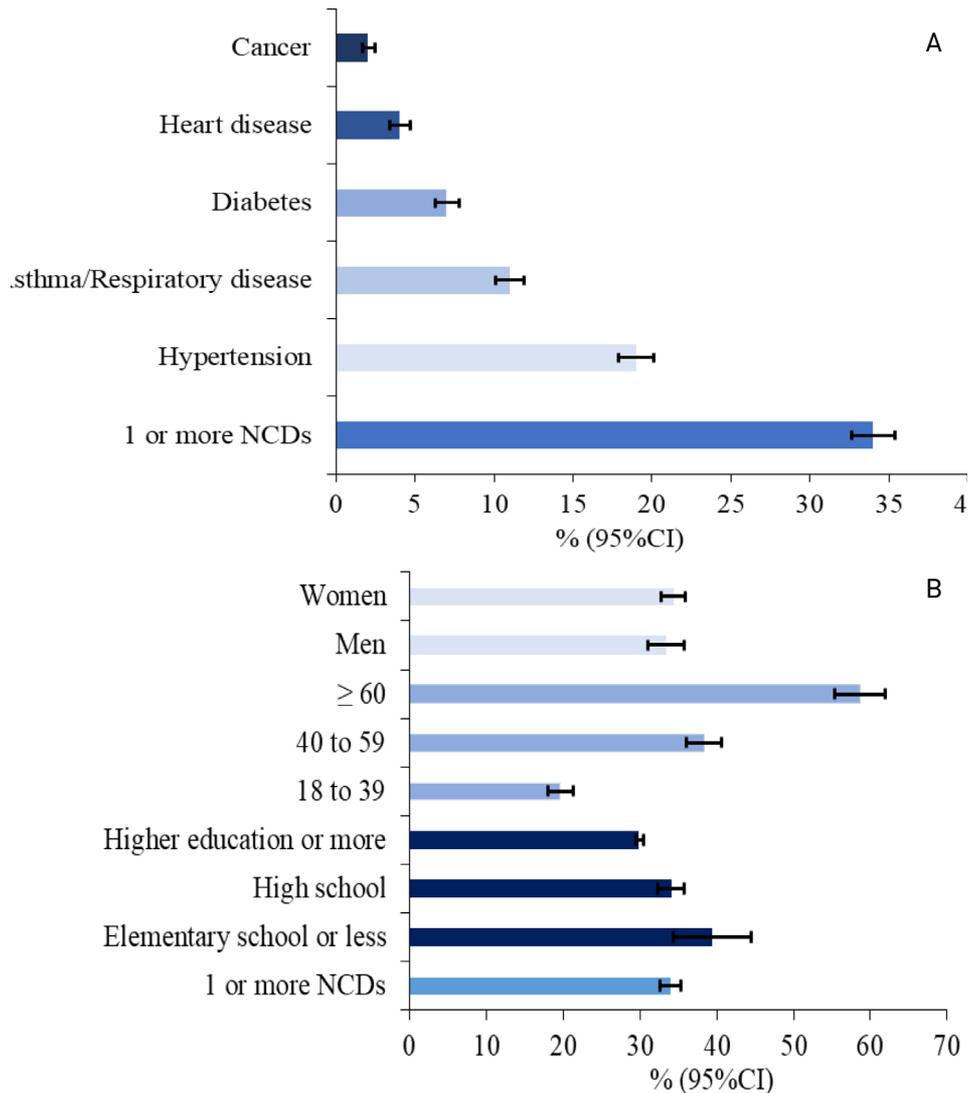
The Poisson regression with robust variance was applied. The Software for Statistics and Data Science (Stata) version 14 was used to process the information, using the survey module, which considers the post-stratification weights.

## RESULTS

A total of 45,161 individuals were evaluated, being: 53.6% (95%CI 52 – 55) women; 45.7% (95%CI 44.3 – 47.1) aged between 18 and 39 years; and 72.4% (95%CI 71.3 – 73.5) with high school education level (data not shown).

The prevalence of hypertension, diabetes, respiratory disease, heart disease, and cancer was 19.3% (95%CI 18.2 – 20.4); 7.2% (95%CI 6.5 – 8); 11.3% (95%CI 10.4 – 12.2); 4.3% (95%CI 3.7 – 5); and 2.4 (95%CI 2.1 – 2.9), respectively (Figure 1A). The prevalence of one or more NCDs was 33.9% (95%CI 32.5 – 35.3), being higher with increasing age (38.3%; 95%CI 36 – 40.6 between 40 and 59 years; and 58.6%; 95%CI 55.3 – 61.9 for those aged 60 years and older) and among those with lower education level (39.3%; 95%CI 34.4 – 44.5), with no differences according to sex (Figure 1B).

Table 1 shows the prevalence and the percentage (%) of changes in the PA and food consumption indicators before and during the pandemic according to the presence of NCDs. There was a 60% reduction in PA in groups without NCDs, and 58% in those with NCDs. The increase in time spent watching television and using computer/tablet was 302 and 43.5%, respectively, in the group without NCDs; and 196.5 and 30.6% in those with NCDs.



NCDs: noncommunicable diseases; 95%CI: 95% confidence interval.

Figure 1. Self-reported prevalence of (A) one or more noncommunicable diseases and (B) having one or more NCDs according to sociodemographic characteristics. Covid – Pesquisa de Comportamentos, Brazil, 2020.

Regarding the consumption of healthy foods, in the population without NCDs, the consumption of vegetables decreased by 10.8% and that of fruits by 3.5%; and, in those with NCDs, it decreased by 12.7% and increased by 37.4%, respectively. It is noteworthy that the reduction in fruit consumption was not significant in both groups. Regarding the consumption of unhealthy foods, in the population without NCDs, the consumption of frozen meals increased 43.6%; of snacks, 42.3%; of chocolate, 14.8%; and of processed

Table 1. Prevalence and percentage of changes in lifestyle before and during the pandemic, according to the presence of one or more noncommunicable diseases. Convid – Pesquisa de Comportamentos, Brazil, 2020.

Variables	No NCDs	% of change	1 or more NCDs	% of change
	% (CI95%)		% (CI95%)	
Sufficient physical activity before	32.3 (30.6 – 34.0)	-60*	25.8 (23.8 – 28.1)	-58.0*
Sufficient physical activity during	12.7 (11.6 – 13.8)		10.8 (9.3 – 12.4)	
Television ≥ 4 hours/day before	8.7 (7.7 – 9.7)	+302*	14.4 (12.6 – 16.3)	+196.5*
Television ≥ 4 hours/day during	35.1 (33.4 – 36.8)		42.7 (40.3 – 45.2)	
Computer/tablet ≥ 4 hours/day before	44.8 (43.1 – 44.6)	+43.5*	41.8 (39.4 – 44.3)	+30.6
Computer/tablet ≥ 4 hours/day during	64.3 (62.5 – 66.0)		54.6 (52.01 – 57.1)	
Adequate consumption of vegetables before	37.0 (35.3 – 38.6)	-10.8*	37.8 (35.6 – 40.1)	-12.7*
Adequate consumption of vegetables during	33.0 (31.4 – 34.6)		33.0 (30.9 – 35.2)	
Adequate consumption of fruits before	31.5 (28.9 – 33.2)	-3.5	25.4 (33.1 – 37.7)	+37.4
Adequate consumption of fruits during	30.4 (28.8 – 32.0)		34.9 (32.6 – 37.3)	
Inadequate consumption of frozen meals before	11.0 (9.5 – 12.6)	+43.6*	8.0 (6.9 – 9.3)	+53.7*
Inadequate consumption of frozen meals during	15.8 (14.3 – 17.5)		12.3 (10.8 – 14.0)	
Inadequate consumption of snacks before	10.4 (9.2 – 11.7)	+42.30*	7.7 (6.5 – 8.8)	+31.2*
Inadequate consumption of snacks during	14.8 (13.4 – 16.3)		10.1 (8.9 – 11.5)	
Inadequate consumption of chocolates before	43.1 (41.4 – 44.9)	+14.8*	37.6 (35.3 – 40.0)	+12.5
Inadequate consumption of chocolates during	49.5 (47.7 – 51.4)		42.3 (39.9 – 44.7)	
Inadequate consumption of processed meats before	41.6 (39.8 – 43.4)	+0.72	39.7 (37.4 – 42.2)	-6
Inadequate consumption of processed meats during	41.9 (40.1 – 43.8)		37.3 (34.9 – 39.7)	

\*Significant difference (without overlapping confidence intervals); NCDs: noncommunicable diseases; 95%CI: 95% confidence interval; -: reduction; +: increase.

meats, 0.72%. There were statistically significant differences in all foods, except processed meats. For people with NCDs, the increase in the consumption of frozen meals, snacks, and chocolates was 53.7, 31.2, and 12.5%, and the reduction was 6% for processed meats; however, the change was not significant for consumption of processed meats and chocolates (Table 1).

Table 2 shows the prevalence and crude and adjusted (PRadj) prevalence ratio of PA, sedentary behaviors, and eating habits during the pandemic, among the population with and

Table 2. Prevalence and crude and adjusted prevalence ratio of physical activity, sedentary behaviors, eating habits, increased consumption of alcohol and cigarettes during the pandemic, according to the presence of one or more noncommunicable diseases. Covid – Pesquisa de Comportamentos, Brazil, 2020.

Variables during the pandemic	No NCDs % (CI95%)	1 or more NCDs % (CI95%)	Crude PR % (CI95%)	Adjusted PR* % (CI95%)
Sufficient physical activity	12.7 (11.6 – 13.8)	10.8 (9.3 – 12.4)	0.85 (0.72 – 1.00)	0.77 (0.65 – 0.92)
Television > 4 hours/day	35.1 (33.4 – 36.8)	42.7 (40.3 – 45.2)	1.22 (1.13 – 1.31)	1.16 (1.08 – 1.26)
Use of computer/tablet > 4 hours/day	64.3 (62.5 – 66.0)	54.6 (52.01 – 57.1)	0.85 (0.80 – 0.89)	0.96 (0.90 – 1.00)
Adequate consumption of vegetables	33.0 (31.4 – 34.6)	33.0 (30.9 – 35.2)	0.99 (0.92 – 1.1)	0.88 (0.81 – 0.96)
Adequate consumption of fruits	30.4 (28.8 – 32.0)	34.9 (32.6 – 37.3)	1.14 (1.05 – 1.25)	0.91 (0.84 – 1.00)
Inadequate consumption of frozen meals	15.8 (14.3 – 17.5)	12.3 (10.8 – 14.0)	0.78 (0.66 – 0.92)	0.98 (0.84 – 1.15)
Inadequate consumption of snacks	14.8 (13.4 – 16.3)	10.1 (8.9 – 11.5)	0.68 (0.58 – 0.80)	0.95 (0.81 – 1.12)
Inadequate consumption of chocolates	49.5 (47.7 – 51.4)	42.3 (39.9 – 44.7)	0.85 (0.80 – 0.91)	0.98 (0.91 – 1.05)
Inadequate consumption of processed meats	41.9 (40.1 – 43.8)	37.3 (34.9 – 39.7)	0.89 (0.82 – 0.96)	1.04 (0.97 – 1.13)
Increased consumption of alcoholic beverages	18.9 (17.3 – 20.6)	15.1 (13.3 – 17.2)	0.80 (0.69 – 0.94)	0.94 (0.81 – 1.10)
Increased number of cigarettes	33.7 (29.1 – 38.6)	34.8 (28.9 – 41.2)	1.03 (0.82 – 1.30)	1.08 (0.87 – 1.34)

\*PR adjusted for sex, age group, and education level; NCDs: noncommunicable diseases; 95%CI: 95% confidence interval.

without one or more NCDs. It was verified that, during the pandemic, people with one or more NCDs were less active (PRadj = 0.77; 95%CI 0.65 – 0.92) and had greater habit of watching television for 4 hours or more/day (PRadj = 1.16; 95%CI 1.08 – 1.26). The time spent using the computer/tablet did not differ between groups (PRadj = 0.96; 95%CI 0.90 – 1).

As for the consumption of healthy and unhealthy foods, it was observed that, during the pandemic, people with NCDs reported inadequate intake of vegetables (PRadj = 0.88; 95%CI 0.81 – 0.96). In addition, people with NCDs had a lower prevalence for the consumption of unhealthy foods, but there were no significant differences after adjusting for age, education level, and sex (Table 2).

In Table 2, when analyzing the increase in consumption of alcoholic beverages and cigarettes during the pandemic according to the diagnosis of NCDs, it is evident that people with at least one NCD had a lower increase in the consumption of alcoholic beverages (15.1%; 95%CI 13.3 – 17.2) compared with those without NCDs (18.9%; 95%CI 17.3 – 20.6). Nevertheless, when the analyses were adjusted, there was no difference between groups. The increase in cigarette consumption was 34.8% (95%CI 28.9 – 41.2) among people with NCDs and 33.7% (95%CI 29.1 – 38.6) among those who did not report NCDs, but without statistically significant differences between groups (Table 2).

## DISCUSSION

The study indicated there were changes in the lifestyles of the population with and without NCDs after the pandemic such as reduced PA and increased sedentary time, reduced consumption of vegetables and increased consumption of ultra-processed foods – such as frozen meals and snacks. When analyzing the prevalence of lifestyles during the pandemic between the two groups, it was observed that people with NCDs were less active, had inadequate consumption of vegetables, and spent more sedentary time watching television. Regarding the consumption of tobacco, alcohol, fruits, and unhealthy foods, there was no difference between groups.

The National Survey of Health (PNS)<sup>30</sup> found similar self-reported prevalence of arterial hypertension (21.4%), diabetes (6.2%), asthma (4.4%), heart disease (4.8%), and cancer (1.8%). The prevalence of one or more NCDs was higher (45.1%); however, the list of NCDs evaluated was more extensive, containing thirteen. In addition, higher prevalence of NCDs was observed with increasing age and low education level<sup>30</sup>. Chronic conditions are known to affect social groups with greater deprivation and more vulnerable to social determinants<sup>31</sup>. Consequently, including NCDs in a scenario of social and economic inequalities individually exacerbates the adverse effects of each disease, as COVID-19, being considered a syndemic, has systemic effects and increases inequities<sup>32</sup>. Furthermore, when addressing COVID-19, attention should also be given to NCDs and their risk factors such as hypertension, obesity, diabetes, chronic cardiovascular and respiratory diseases, and cancer<sup>32</sup>.

The worsening of lifestyles during the pandemic observed in this study was also identified in other surveys<sup>20,21,33,34</sup>. Such changes may impact the quality of life and health of the population, resulting in an epidemic of preventable deaths among people affected with NCDs<sup>19</sup>. Hence, it is essential to implement a health promotion agenda<sup>35</sup> and to strengthen primary health care in facing the impacts of the pandemic and in social distancing<sup>36</sup>, with emphasis on maintaining comprehensive follow-up actions for NCD patients, using telemonitoring and telehealth<sup>37</sup>.

This study identified that people with one or more NCDs had irregular practice of PA during the pandemic. It is noteworthy that PA is essential for the maintenance and promotion of health and quality of life<sup>38,39</sup>, and the recommendation is to maintain an active life<sup>40</sup>. The World Health Organization<sup>41</sup> encourages health professionals and managers to seek strategies to maintain active and healthy habits during the period of social distancing, especially for population groups considered at risk and, therefore, more vulnerable such as older adults and the population affected with NCDs<sup>9,40,42</sup>.

The results indicate that the population with NCDs spent more time watching television during the pandemic. This fact is worrying, considering that a sedentary behavior has a detrimental effect on health, which can contribute to the onset and worsening of NCDs in addition to rapidly deteriorating cardiovascular health and causing premature deaths<sup>43,44</sup>.

It has been discussed that social distancing implies changes in eating habits of the population in general, with reduced consumption of fruits and vegetables and increased consumption of frozen meals, snacks, and sweets. In Italy, 34.4% of individuals had their diet worsened during the pandemic<sup>34</sup>. In the United States of America, there was an increase in the volume of purchases in supermarkets, with a stock of ultra-processed foods with high energy density such as chips, popcorn, chocolate, and ice cream<sup>45,46</sup>.

People with NCDs showed lower consumption of vegetables and similar consumption of ultra-processed foods. These findings can be explained by the difficulty in supplying and replacing fresh and healthy food as well as by the ease of purchase and storage of ultra-processed products<sup>47</sup>. A study carried out among diabetic patients in Brazil identified an important adherence to social distancing due to the perceived increased risk for COVID-19; however, this population reduced the use of healthcare services and there was a report of difficulty in purchasing foods<sup>20</sup>.

The increase in alcohol consumption during the COVID-19 pandemic, identified in this study, has also occurred in other contexts and has been attributed to psychological distress and financial difficulties<sup>33</sup>, in addition to greater physical availability and accessibility<sup>33,48</sup>. Although there were no differences between the population with and without NCDs after adjustment, the risk of this finding is emphasized, as alcohol can potentially worsen the clinical course of COVID-19 infection<sup>49</sup>, increasing the susceptibility to viral infection and aggravating the situation of people with NCDs<sup>50</sup>.

Tobacco consumption increased in more than a third of smokers, with or without NCDs. Tobacco is an important risk factor for NCDs, both for cancer and respiratory diseases, being contraindicated in any situation<sup>51</sup>. Still, there is evidence that smoking can aggravate the

course of COVID-19<sup>52,53</sup>. Among factors involved in the relation between smoking and this viral infection are the increase in angiotensin-converting enzyme 2 (ECA2) among smokers<sup>52,53</sup>, the increase in viral contamination by taking the cigarette to the mouth<sup>54</sup>, and the worsening in cardiorespiratory performance<sup>55</sup>.

In South Africa, in order to tackle smoking during the COVID-19 pandemic, the sale of tobacco and nicotine products has been banned, which should be understood as a double attempt to protect the population against COVID-19 and the avoidable burden of tobacco<sup>56</sup>. Therefore, advancing new regulatory measures<sup>57</sup> and monitoring the actions of tobacco industries<sup>58</sup> should be a priority in government agendas, especially during pandemic periods, in order to save lives<sup>58</sup>.

It should be noted that the study showed a worsening of lifestyles, with these changes being even more intense in the adult population with NCDs. Thus, a scenario of worsened indicators can be predicted, including increased mortality from NCDs, which may compromise the achievement of global goals such as reducing premature mortality by 30% by 2030<sup>5</sup>.

In this context, it is worth highlighting the contemporaneity of intersectoral policies for the prevention and control of NCDs in response to COVID-19. Prevention measures concerning NCDs should not be interrupted. Healthcare services, especially primary health care, must adapt to this new reality in order to support and manage the increase in risks and to continue providing health care for NCDs patients. Professionals in the field must be involved in planning strategies to respond to COVID-19, in such a way they can guarantee the right to health. Nevertheless, specific recommendations should be nationally and locally made available for patients with NCDs, their families, and their caregivers<sup>32</sup>. Furthermore, the COVID-19 pandemic and the NCD epidemic show the urgency in advancing stricter regulatory measures for tobacco, alcohol, and unhealthy food, promoting PA, and strengthening health systems during and after the pandemic<sup>1</sup>.

Among the limitations of the study, it is pointed out the fact that data were collected through the Web, which may not reach all population strata, considering that not everyone has access to this means of communication, which may lead to under- or overestimation of proportion of indicators. This limitation was minimized by sample calibration by applying post-stratification weights. Another issue refers to the fact that the questions are self-reported, and may be subject to memory bias. The fact that data collection took place at the beginning of the pandemic (3<sup>rd</sup> month) may be subject to situational changes throughout the temporal evolution of the pandemic.

All in all, our findings suggest that adults with NCDs had their lifestyles more altered due to reduced PA, increased sedentary lifestyle, reduced consumption of healthy foods, and increased consumption of ultra-processed foods. Within this context, it is imperative to adopt public policies that foment health promotion actions as well as regulatory measures for the protection and prevention of NCDs and the expansion of primary health care for patients with NCDs. If urgent measures are not taken, there is a risk of not achieving the goals of Agenda 2030 – SDG concerning the reduction of NCDs.

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## REFERENCES

1. World Health Organization. Noncommunicable Diseases Progress Monitor 2020. Geneva: World Health Organization; 2020.
2. Malta DC, França E, Abreu DMX, Perillo RD, Salmen MC, Teixeira R, et al. Mortality due to non-communicable diseases in the Brazil, 1990 to 2015, according to estimates from the Global Burden of Disease study. *São Paulo Med J* 2017; 135(3): 213-21. <https://doi.org/10.1590/1516-3180.2016.0330050117>
3. World Health Organization. World health statistics 2018: monitoring health for the SDGs, sustainable development goals. Geneva: World Health Organization; 2019.
4. Malta DC, Duncan BB, Schmidt MI, Teixeira R, Ribeiro ALP, Felisbino-Mendes MC, et al. Trends in mortality due to non-communicable diseases in the Brazilian adult population: national and subnational estimates and projections for 2030. *Popul Health Metrics* 2020; 18(Supl. 1): 16. <https://doi.org/10.1186/s12963-020-00216-1>
5. United Nations. Transforming our world: the 2030 Agenda for Sustainable Development [Internet]. 2016 [access on Oct. 11, 2020]. Available from: <https://sustainabledevelopment.un.org/post2015/transformingourworld>
6. World Health Organization. The impact of the COVID-19 pandemic on noncommunicable disease resources and services: results of a rapid assessment. Geneva: World Health Organization; 2020.
7. The Lancet. COVID-19: a new lens for non-communicable diseases. *Lancet* 2020; 396(10252): 649. [https://doi.org/10.1016/S0140-6736\(20\)31856-0](https://doi.org/10.1016/S0140-6736(20)31856-0)
8. Clark A, Jit M, Warren-Gash C, Guthrie B, Wang HHX, Mercer SW, et al. Global, regional, and national estimates of the population at increased risk of severe COVID-19 due to underlying health conditions in 2020: a modelling study. *Lancet Global Health* 2020; 8(8): E1003-17. [https://doi.org/10.1016/S2214-109X\(20\)30264-3](https://doi.org/10.1016/S2214-109X(20)30264-3)
9. Azarpazhooh MR, Morovatdar N, Avan A, Phan TG, Divani AA, Yassi N, et al. COVID-19 Pandemic and Burden of Non-Communicable Diseases: An Ecological Study on Data of 185 Countries. *J Stroke Cerebrovasc Dis* 2020; 29(9): 105089. <https://doi.org/10.1016%2Fj.jstrokecerebrovasdis.2020.105089>
10. Kluge HHP, Wickramasinghe K, Rippin HL, Mendes R, Peters DH, Kontsevaya A, et al. Prevention and control of non-communicable diseases in the COVID-19 response. *Lancet* 2020; 395(10238): 1678-80. [https://doi.org/10.1016/S0140-6736\(20\)31067-9](https://doi.org/10.1016/S0140-6736(20)31067-9)
11. Richardson S, Hirsch JS, Narasimhan M, Crawford JM, McGinn T, Davidson KW, et al. Presenting Characteristics, Comorbidities, and Outcomes Among 5700 Patients Hospitalized With COVID-19 in the New York City Area. *JAMA* 2020; 323(20): 2052-9. <https://doi.org/10.1001%2Fjama.2020.6775>
12. Nussbaumer-Streit B, Mayr V, Dobrescu AI, Chapman A, Persad E, Klerings I, et al. Quarantine alone or in combination with other public health measures to control COVID-19: a rapid review. *Cochrane Database of Syst Rev* 2020; (4): CD013574. <https://doi.org/10.1002/14651858.cd013574>
13. Aquino E, Silveira IH, Pescarini J, Aquino R, Souza-Filho JA, Rocha AS, et al. Social distancing measures to control the COVID-19 pandemic: potential impacts and challenges in Brazil. *Ciênc Saúde Colet* 2020; 25(Supl. 1): 2423-46. <https://doi.org/10.1590/1413-81232020256.1.10502020>
14. Malta DC, Szwarcwald CL, Barros MBA, Gomes CS, Machado ÍE, Souza Júnior PRB, et al. The COVID-19 Pandemic and changes in adult Brazilian lifestyles: a cross-sectional study, 2020. *Epidemiol Serv Saúde* 2020; 29(4): e2020407. <https://doi.org/10.1590/s1679-49742020000400026>

15. van Zyl-Smit RN, Richards G, Leone FT. Tobacco smoking and COVID-19 infection. *Lancet Respir Med* 2020; 8(7): 664-5. [https://doi.org/10.1016/S2213-2600\(20\)30239-3](https://doi.org/10.1016/S2213-2600(20)30239-3)
16. Stanton R, To QG, Khalesi S, Williams SL, Alley SJ, Thwaite TL, et al. Depression, Anxiety and Stress during COVID-19: Associations with Changes in Physical Activity, Sleep, Tobacco and Alcohol Use in Australian Adults. *Int J Environ Res Public Health* 2020; 17(11): 4065. <https://doi.org/10.3390%2Fijerph17114065>
17. García-Álvarez L, Fuente-Tomás L, Sáiz PA, García-Portilla MP, Bobes J. Will changes in alcohol and tobacco use be seen during the COVID-19 lockdown? *Adicciones* 2020; 32(2): 85-9. <https://doi.org/10.20882/adicciones.1546>
18. Clay JM, Parker MO. Alcohol use and misuse during the COVID-19 pandemic: a potential public health crisis?. *Lancet Public Health* 2020; 5(5): e259. [https://doi.org/10.1016/S2468-2667\(20\)30088-8](https://doi.org/10.1016/S2468-2667(20)30088-8)
19. Pan American Health Organization. Diretora da OPAS afirma que luta contra a pandemia de COVID-19 deve incluir tratamento de doenças crônicas [Internet]. Washington, D.C.: Pan American Health Organization; 2020 [access on Oct. 11, 2020]. Available from: [https://www.paho.org/bra/index.php?option=com\\_content&view=article&id=6181:diretora-da-opas-afirma-que-luta-contra-a-pandemia-de-covid-19-deve-incluir-tratamento-de-doencas-cronicas&Itemid=839](https://www.paho.org/bra/index.php?option=com_content&view=article&id=6181:diretora-da-opas-afirma-que-luta-contra-a-pandemia-de-covid-19-deve-incluir-tratamento-de-doencas-cronicas&Itemid=839)
20. Barone MTU, Harnik SB, Luca PV, Lima BLS, Wieselberg RJP, Ngongo B, et al. The impact of COVID-19 on people with diabetes in Brazil. *Diabetes Res Clin Pract* 2020; 166: 108304. <https://doi.org/10.1016/j.diabres.2020.108304>
21. Barone MTU, Villarroel D, Luca PV, Harnik SB, Lima BLS, Wieselberg RJP, et al. COVID-19 impact on people with diabetes in South and Central America (SACA region). *Diabetes Res Clin Pract* 2020; 166: 108301. <https://doi.org/10.1016/j.diabres.2020.108301>
22. Fundação Oswaldo Cruz. Instituto de Comunicação e Informação Científica e Tecnológica em Saúde. ConVid – Pesquisa de Comportamentos [Internet]. Rio de Janeiro: Fundação Oswaldo Cruz; 2020 [access on Dec. 10, 2020]. Available from: [https://convid.fiocruz.br/index.php?pag=questionario\\_adulto](https://convid.fiocruz.br/index.php?pag=questionario_adulto)
23. Costa BRL. Bola de neve virtual: o uso das redes sociais virtuais no processo de coleta de dados de uma pesquisa científica. *Rev Interdiscip Gestão Social* [Internet] 2018 [access on Oct. 11, 2020]; 7(1): 15-37. Available from: <https://portalseer.ufba.br/index.php/rigs/article/view/24649>
24. Instituto Brasileiro de Geografia e Estatística. Pesquisa Nacional por Amostra de Domicílios Contínua - PNAD Contínua [Internet]. Rio de Janeiro: Instituto Brasileiro de Geografia e Estatística; 2019 [access on Oct. 11, 2020]. Available from: <https://www.ibge.gov.br/estatisticas/sociais/trabalho/9171-pesquisa-nacional-por-amostra-de-domicilios-continua-mensal.html?=&t=o-que-e>
25. Silva PLN. Calibration estimation. When and why, how much and how [Internet]. Rio de Janeiro: Instituto Brasileiro de Geografia e Estatística; 2004 [access on Oct. 11, 2020]. Available from: <https://biblioteca.ibge.gov.br/bibliotecacatalogo?id=281040&view=detalhes>
26. World Health Organization. Global recommendations on physical activity for health. Geneva: World Health Organization; 2011.
27. Mielke GI, Hallal PC, Rodrigues GBA, Szwarcwald CL, Santos FV, Malta DC. Prática de atividade física e hábito de assistir à televisão entre adultos no Brasil: Pesquisa Nacional de Saúde 2013. *Epidemiol Serv Saúde* 2015; 24(2): 277-86. <https://doi.org/10.5123/S1679-49742015000200010>
28. World Health Organization. Diet, nutrition and the prevention of chronic diseases: report of a joint WHO/FAO expert consultation. Geneva: World Health Organization; 2003.
29. Monteiro CA, Cannon G, Lawrence M, Costa Louzada ML, Machado PP. Ultra-processed foods, diet quality, and health using the NOVA classification system [Internet]. Roma: Food and Agriculture Organization of the United Nations; 2019 [access on Oct. 11, 2020]. Available from: <http://www.fao.org/3/ca5644en/ca5644en.pdf>
30. Malta DC, Stopa S, Szwarcwald CL, Gomes NL, Silva Júnior JB, Reis AAC. Surveillance and monitoring of major chronic diseases in Brazil – National Health Survey, 2013. *Rev Bras Epidemiol* 2015; 18(Supl. 2): 3-16. <https://doi.org/10.1590/1980-5497201500060002>
31. Abrams EM, Szeffler SJ. COVID-19 and the impact of social determinants of health. *Lancet Respir Med* 2020; 8(7): 659-61. [https://doi.org/10.1016/S2213-2600\(20\)30234-4](https://doi.org/10.1016/S2213-2600(20)30234-4)
32. Horton R. Offline: COVID-19 is not a pandemic. *Lancet* 2020; 396(10255): 874. [https://doi.org/10.1016/S0140-6736\(20\)32000-6](https://doi.org/10.1016/S0140-6736(20)32000-6)
33. Rehm J, Kilian C, Ferreira-Borges C, Jernigan D, Monteiro M, Parry CDH, et al. Alcohol use in times of the COVID 19: Implications for monitoring and policy. *Drug Alcohol Rev* 2020; 39(4): 301-4. <https://doi.org/10.1111/dar.13074>
34. Di Renzo L, Gualtieri P, Pivari F, Soldati L, Attinà A, Cinelli G, et al. Eating habits and lifestyle changes during COVID-19 lockdown: an Italian survey. *J Transl Med* 2020; 18(1): 229. <https://doi.org/10.1186/s12967-020-02399-5>

35. Van den Broucke S. Why health promotion matters to the COVID-19 pandemic, and vice versa. *Health Promot Int* 2020; 35(2): 181-6. <https://doi.org/10.1093/heapro/daaa042>
36. Daumas RP, Silva GA, Tasca R, Leite IC, Brasil P, Greco DB, et al. The role of primary care in the Brazilian healthcare system: limits and possibilities for fighting COVID-19. *Cad Saúde Pública* 2020; 36(6): e00104120. <https://doi.org/10.1590/0102-311X00104120>
37. Caetano R, Silva AB, Guedes ACCM, Paiva CCN, Ribeiro GR, Santos DL, et al. Challenges and opportunities for telehealth during the COVID-19 pandemic: ideas on spaces and initiatives in the Brazilian context. *Cad Saúde Pública* 2020; 36(5): e00088920. <https://doi.org/10.1590/0102-311x00088920>
38. Ferreira MJ, Irigoyen MC, Consolim-Colombo F, Saraiva JFK, Angelis K. Physically Active Lifestyle as an Approach to Confronting COVID-19. *Arq Bras Cardiol* 2020; 114(4): 601-2. <https://doi.org/10.36660/abc.20200235>
39. Crochemore-Silva I, Knuth AG, Wendt A, Nunes BP, Hallal PC, Santos LP, et al. Physical activity during the COVID-19 pandemic: a population-based cross-sectional study in a city of South Brazil. *Ciêns Saúde Colet* 2020; 25(11): 4249-58. <https://doi.org/10.1590/1413-812320202511.29072020>
40. Sallis JF, Adlakha D, Oyeyemi A, Salvo D. An international physical activity and public health research agenda to inform coronavirus disease-2019 policies and practices. *J Sport Health Sci* 2020; 9(4): 328-34. <https://doi.org/10.1016/j.jshs.2020.05.005>
41. Pan American Health Organization. OPAS incentiva comunidades a apoiarem as pessoas no enfrentamento da pandemia de COVID-19 [Internet]. Washington, D.C.: Pan American Health Organization; 2020 [access on Oct. 11, 2020]. Available from: [https://www.paho.org/bra/index.php?option=com\\_content&view=article&id=6278:opas-incentiva-comunidades-a-apoiarem-as-pessoas-no-enfrentamento-da-pandemia-de-covid-19&Itemid=839](https://www.paho.org/bra/index.php?option=com_content&view=article&id=6278:opas-incentiva-comunidades-a-apoiarem-as-pessoas-no-enfrentamento-da-pandemia-de-covid-19&Itemid=839)
42. Martinez-Ferran M, de la Guía-Galipienso F, Sanchis-Gomar F, Pareja-Galeano H. Metabolic Impacts of Confinement during the COVID-19 Pandemic Due to Modified Diet and Physical Activity Habits. *Nutrients* 2020; 12(6): 1549. <https://doi.org/10.3390/nu12061549>
43. Peçanha T, Goessler KF, Roschel H, Gualano B. Social isolation during the COVID-19 pandemic can increase physical inactivity and the global burden of cardiovascular disease. *Am J Physiol Heart Circ Physiol* 2020; 318(6): H1441-6. <https://doi.org/10.1152/ajpheart.00268.2020>
44. Narici M, De Vito G, Franchi M, Paoli A, Moro T, Marcolin G, et al. Impact of sedentarism due to the COVID-19 home confinement on neuromuscular, cardiovascular and metabolic health: Physiological and pathophysiological implications and recommendations for physical and nutritional countermeasures. *Eur J Sport Sci* 2020; 12: 1-22. <https://doi.org/10.1080/17461391.2020.1761076>
45. Bhutani S, Cooper JA. COVID-19 related home confinement in adults: weight gain risks and opportunities. *Obesity (Silver Spring)* 2020; 28(9): 1576-7. <https://doi.org/10.1002/oby.22904>
46. The Nielsen Company. COVID-19: Tracking the impact 2020 [Internet]. The Nielsen Company; 2020 [access on Oct. 11, 2020]. Available from: <https://www.nielsen.com/us/en/>
47. Silva Filho OJ, Gomes Júnior NN. The future at the kitchen table: COVID-19 and the food supply. *Cad Saúde Pública* 2020; 36(5): e00095220. <https://doi.org/10.1590/0102-311X00095220>
48. Alcohol and Public Policy Group. Alcohol: No Ordinary Commodity – a summary of the second edition. *Addiction* 2010; 105(5): 769-79. <https://doi.org/10.1111/j.1360-0443.2010.02945.x>
49. Szabo G, Saha B. Alcohol's Effect on Host Defense. *Alcohol Res [Internet]* 2015 [access on Oct. 11, 2020]; 37(2): 159-70. Available from: <https://www.ncbi.nlm.nih.gov/pmc/articles/PMC4590613/pdf/arcr-37-2-159.pdf>
50. Sidor A, Rzymiski P. Dietary Choices and Habits During COVID-19 Lockdown: Experience From Poland. *Nutrients* 2020; 12(6): 1657. <https://doi.org/10.3390/nu12061657>
51. Malta DC, Silva AG, Machado ÍE, Sá ACMGN, Santos FM, Prates EJS, et al. Trends in smoking prevalence in all Brazilian capitals between 2006 and 2017. *J Bras Pneumol* 2019; 45(5): e20180384. <https://doi.org/10.1590/1806-3713/e20180384>
52. Olds JL, Kabbani N. Is Nicotine Exposure Linked to Cardiopulmonary Vulnerability to COVID-19 in the General Population? *FEBS J* 2020; 287(17): 3651-5. <https://doi.org/10.1111/febs.15303>
53. Leung JM, Yang CX, Tam A, Shaipanich T, Hackett TL, Singhera GK, et al. ACE-2 Expression in the Small Airway Epithelia of Smokers and COPD Patients: Implications for COVID-19. *Eur Respir J* 2020; 55(5): 2000688. <https://doi.org/10.1183/13993003.00688-2020>
54. Silva ALO, Moreira JC, Martins SR. COVID-19 and smoking: a high-risk association. *Cad Saúde Pública* 2020; 36(5): e00072020.

55. Cattaruzza MS, Zagà V, Gallus S, D'Argenio P, Gorini G. Tobacco smoking and COVID-19 pandemic: old and new issues. A summary of the evidence from the scientific literature. *Acta Biomed* 2020; 91(2): 106-12. <https://doi.org/10.23750/abm.v91i2.9698>
56. Egbe CO, Ngobese SP. COVID-19 lockdown and the tobacco product ban in South Africa. *Tob Induc Dis* 2020; 18: 39. <https://doi.org/10.18332/tid/120938>
57. World Health Organization. Tackling NCDs: "best buys" and other recommended interventions for the prevention and control of noncommunicable diseases. Geneva: World Health Organization; 2017.
58. Zato ski M, Gilmore AB, Hird TR. The two faces of the tobacco industry during the COVID-19 pandemic [Internet]. *Tobacco Control* 2020 [access on Oct. 11, 2020]. Available from: <https://blogs.bmj.com/>

[tc/2020/05/10/the-two-faces-of-the-tobacco-industry-during-the-covid-19-pandemic/](https://blogs.bmj.com/tc/2020/05/10/the-two-faces-of-the-tobacco-industry-during-the-covid-19-pandemic/)

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