Choosing bottled over tapped: drinking water in the Dominican Republic
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ABSTRACT

While not designated as an improved drinking water source, bottled water is increasingly used by households in low- and middle-income countries as families strive to obtain perceived safer drinking water. The Dominican Republic has high levels of bottled water use despite high levels of piped water access. This study aimed to identify household characteristics that are associated with choosing bottled over tapped drinking water in the Dominican Republic through further examination of data available from a nationally representative Demographic and Healthy Survey from 2007. Among households reporting tapped water as their primary non-drinking water source, 59.6% identified bottled water as their principal drinking water source in comparison with 24.7% identifying tapped water. Greater wealth explained the largest amount of variance in bottled over tapped drinking water. Other hypothesized variables related to choosing bottled over tapped included residence in more urban settings, having a young child in the household, having fewer persons in the household, and a head of household who is female, younger and with higher education. Nationally, representative data which include components investigating perceptions about drinking water and actual quality of drinking water are required to further understand this phenomenon and its impact.

Key words | bottled water, domestic water consumption, Dominican Republic, drinking water

INTRODUCTION

Despite increasing access to drinking water sources that are designated as ‘improved’, an estimated 780 million still rely on ‘unimproved’ sources (UNICEF & WHO 2012). Furthermore, access to an ‘improved’ drinking water source does not necessarily indicate a safe water source (UNICEF & WHO 2012; Bain et al. 2014), nor does it indicate a standard that may be acceptable to the potential user. Accordingly, even if households have access to a source classified as ‘improved’ (e.g., piped water to premise) by international bodies, household decision-makers may still pursue alternatives that are perceived to be better, such as bottled water, despite potential additional costs, environmental impacts, and questionable gains (Massound et al. 2013).

Families are increasingly resorting to the use of bottled water. It has been estimated that using bottled water to meet drinking water needs increased from 37 to 228 million between 1990 and 2010, despite most of those engaged in such practice having access to tapped water on their premises (UNICEF & WHO 2012). This appears to be the case in the Dominican Republic (DR). In a report of 14 low- and middle-income countries (LMIC), the DR had by far the highest level of bottled water use in both urban and rural settings (UNICEF & WHO 2008). Based on data from the 2007 Demographic and Health Survey (DHS) from the DR, 57.0% of a nationally representative sample-designated-bottled water as their primary drinking source despite the majority having access to a piped water source to their home or compound (Centro de Estudios Sociales y Demográficos & Macro International Inc. 2008). Identifying characteristics of bottled water users in this country may provide additional insight into this phenomenon within LMICs.

Several household level characteristics may be related to bottled water use. Given the greater costs of bottled water...
over tapped, it is expected that bottled water would have a particularly strong positive relationship with income or economic status, particularly in LMICs. The relationship of income and bottled water use within high-income countries has been less clear. Within multivariate analysis, three small US studies did not find a significant relationship between income and bottled water use (Abrahams et al. 2000; Hobson et al. 2007; Gorelick et al. 2011), although a larger Canadian study did find a positive relationship (Dupont & Jahan 2012).

Several other household variables may also be related to bottled water use. It may be associated with urban residence in some countries (UNICEF & WHO 2008). This may particularly be the case for some LMICs where bottled water distribution to some rural areas may be limited. Number of household members might be inversely related to this practice given that larger households might make routine use of bottled water too expensive. This was suggested in a study of water sachet use in urban Ghana (Stoler et al. 2012). Given that parents may perceive bottled water as safer for their children in some situations (e.g., Hobson et al. 2007; Gorelick et al. 2011), bottled water use may be higher in households with young children. A small study in the DR found high use of bottled water for young children, although, this was not contrasted with households without young children (McLennan & Farrelly 2010). The Canadian study referenced above did not find a relationship with young children in the household (Dupont & Jahan 2012), nor did the above-mentioned study in Ghana (Stoler et al. 2012).

In addition to household-level variables, specific head-of-household characteristics may also relate to bottled water practices. It is hypothesized that households headed by younger, female and/or higher educated persons would be more likely to choose bottled water. Female-headed households may be associated with increased investment in health practices (Rogers 1996) and if bottled water is generally perceived as a healthier choice or with lower risk, this variable may relate to bottled water use. In a large US study, female respondents were more likely to indicate bottled water use than males (Hu et al. 2011). Younger age of respondents has been found in some studies to relate to greater bottled water use (e.g., Abrahams et al. 2000; Hu et al. 2011). The relationship between education level and bottled water use has been less clear within some of the North American studies, however, a number of these focused on cut-points at the high school level (e.g., Abrahams et al. 2000; Hu et al. 2011; Dupont & Jahan 2012) while studies in many LMICs may need to consider a further breakdown of education levels below that of high school.

The aim of this study was to examine household and head-of-household characteristics that may influence choosing bottled water over tapped water for drinking water purposes in the DR. The following household level characteristics were hypothesized to have a positive relationship with bottled water use: (i) higher levels of wealth, (ii) residence situated in a more urban setting, (iii) fewer household members, (iv) having a young child in the household, and the following head-of-household characteristics were also hypothesized to be related to higher levels of bottled water use: (v) female, (vi) younger age, and (vii) higher education level.

**METHODS**

**Sample**

The sample for this study was based on data from the 2007 Demographic and Health Survey for the Dominican Republic (DHS-DR). The original DHS-DR collected data from 32,431 households using a probabilistic, stratified, two-stage cluster design in which enumeration areas were randomly drawn from the 2002 census, and then households within the enumeration areas were randomly selected to participate in the survey (Measure DHS 2011). Data, without any personal identifying information, are made available free from the DHS programme for academic research. Ethics reviews for the original survey were obtained by an in-country ethics review panel and participants completed informed consent prior to survey interview (ICF International 2012).

For this specific study, households with any missing data for any dependent or independent variables for this study were dropped ($n = 1,096, 3.4\%$), with most of these being a function of missing education level of head-of-household ($n = 891$). This resulted in a sample size of 31,320 households (31,220 households when weighted) for this study.
Measures

Within the DHS-DR household questionnaire, the head-of-household was asked what the principal drinking water source was for household members. Bottled water was one of eight options, plus an ‘other’ category to identify alternative sources. Similarly, the head-of-household was asked what the principal source of water was for household uses other than drinking (e.g., bathing, washing dishes) (labelled ‘non-drinking purposes’ in this study) and given six options, plus ‘other’. Only a single response was allowed for each of these two questions.

For this specific study, the option of tanker truck and small truck were collapsed into ‘trucked water’ for the analysis. Tapped water inside and outside the household was initially considered separately and then collapsed to ‘tapped water’.

The dependent variable for the bivariate and multivariate analysis for this study is whether the respondent indicated that bottled or tapped water was the primary drinking water source. Independent variables included a set of household level characteristics: (i) household wealth (based on quintiles generated from a DHS developed composite measure which included household assets and facilities (Measure DHS 2013)), (ii) the place of residence (large city, small city, town, countryside), (iii) number of household members, and (iv) whether there was a child under 5 years of age in the household. Also considered were characteristics of the head-of-household (respondent): (v) gender, (vi) age, and (vii) level of education. These variables were not modified from the original DHS-DR survey for this analysis.

Analysis

The main report from the DHS-DR provides the frequency of the various primary drinking water sources for the overall national sample and by geographic distribution (Centro de Estudios Sociales y Demográficos & Macro International Inc. 2008). However, it does not provide bivariate or multivariate analysis of relationships of variables with drinking water source nor evaluation of subgroup patterns.

The analysis for this specific study begins with the ‘full sample’, with the above-described restrictions, to initially examine the frequency distribution of principal drinking water sources by non-drinking water sources (Table 1). For all subsequent analysis, the sample was further restricted to those reporting tapped water as their principal non-drinking water source and reporting either tapped water or bottled water as their principal drinking water source (n = 21,439; weight n = 22,702). This approach ensured that the household had tapped water access as the structure of the questionnaire did not otherwise allow determination of tapped water access. The further restriction facilitated the contrast between those choosing bottled vs. tapped water for drinking purposes.

Weighting was used to factor in the sampling frame and allow for the generation of population-level estimates for frequency distributions and mean values. In accordance with DHS user guidelines, weighting was not used for bivariate or multivariate analyses. Student’s t-tests, Pearson’s Chi-square tests, and Mantel–Haenszel linear-by-linear association Chi-square tests were used for bivariate analysis. Logistic regression was used for multivariate analysis.

RESULTS

Tapped water into the household (49.6%) and tapped water outside of the household (56.7%) were the most common principal water sources for non-drinking purposes with other sources (e.g., well water) endorsed by less than 5% of the sample each (Table 1). In contrast, bottled water was identified as the most common principal drinking water source (57.2%), distantly followed by tapped water outside of the household (12.7%) and trucked water (10.4%). Bottled water use was the most common type of principal drinking water source regardless of principal non-drinking water source except for those relying on surface water and rainwater as their principal non-drinking water sources.

For the next analysis, the subsample (n = 22,702, weighted) with the following characteristics was extracted from the above total sample: those who identified tapped water (either inside or outside the household) as their principal non-drinking water source AND who indicated their principal drinking water source was either bottled or tapped. Within this subgroup, 70.7% indicated bottled...
water as their principal drinking water source in contrast to 29.3% who indicated tapped water (Table 2).

All considered household characteristics demonstrated a significant bivariate relationship with choosing bottled water as the principal drinking water source (Table 2). The relationship with index of wealth is most striking with 92.5% of the richest quintile using bottled water as their principal drinking water source in contrast to 28.6% of the poorest quintile. However, over half (59.2%) of the second poorest quintile reported bottled water as their principal drinking water source. When considering the whole sample, i.e., not limiting it to those with tapped water as their principal drinking water source, 47.0% of the second poorest quintile still reported bottled water as their principal drinking water source.

As expected, city dwellers were more likely to use bottled water; however, 47.8% of those residing in the countryside also reported relying principally on bottled water for drinking purposes in this subsample. For the whole sample, 30.6% of those in the countryside reported bottled water as their principal drinking water source.

Households relying on bottled water had slightly fewer members than those who did not. Head-of-household characteristics also demonstrated significant relationships to the choice of drinking water. Bottled water was highly related to higher educational attainment. Also as hypothesized, the head-of-household being female and younger were also related to bottled water use. Inconsistent with the original hypothesis, households with young children were slightly less likely to report reliance on bottled water for drinking purposes in the bivariate analysis.

Next, the hypothesized variables were examined to determine their independent relationship to bottled water use and the extent of variance explained by these variables through use of a logistic regression model. All hypothesized variables demonstrated a significant relationship to bottled water use in the expected direction (Table 3). Unlike in the bivariate analysis, having a young child in the household was now related to bottled water use. The Nagelkerke $R^2$ value for the full model was 0.450. However, most of this was explained by the household wealth index as the Nagelkerke $R^2$ value with only household wealth in the model was 0.402.

An important minority (10.4%) of the whole sample reported drinking water delivered by trucks as their principal drinking water source (Table 1). This subgroup was excluded from the above analysis in order to have a clear ‘bottled water’ group. However, in practice, households may have reusable 20 litres water bottles filled from such trucks and this may represent a practice that overlaps conceptually with

### Table 1: Distribution of principal water source for drinking and non-drinking purposes

<table>
<thead>
<tr>
<th>Principal drinking water sources</th>
<th>Tapped (into household)</th>
<th>Tapped (outside of household)</th>
<th>Well water</th>
<th>Trucked water</th>
<th>Surface watera</th>
<th>Rainwater</th>
<th>Other</th>
<th>Total</th>
</tr>
</thead>
<tbody>
<tr>
<td>Bottled water</td>
<td>70.2 (10,870)b</td>
<td>45.3 (5,188)b</td>
<td>38.8 (552)</td>
<td>65.4 (768)</td>
<td>20.0 (191)</td>
<td>32.7 (181)</td>
<td>56.3 (107)</td>
<td>57.2 (17,856)</td>
</tr>
<tr>
<td>Tapped (outside of household)</td>
<td>1.0 (160)b</td>
<td>32.8 (3,751)b</td>
<td>0.6 (9)</td>
<td>0.7 (8)</td>
<td>3.5 (33)</td>
<td>0.5 (3)</td>
<td>1.6 (3)</td>
<td>12.7 (3,967)</td>
</tr>
<tr>
<td>Trucked water</td>
<td>8.7 (1,351)</td>
<td>11.5 (1,314)</td>
<td>6.5 (93)</td>
<td>29.7 (349)</td>
<td>5.6 (53)</td>
<td>13.0 (72)</td>
<td>11.6 (22)</td>
<td>10.4 (3,254)</td>
</tr>
<tr>
<td>Tapped (into household)</td>
<td>16.7 (2,586)b</td>
<td>1.3 (149)b</td>
<td>0.2 (3)</td>
<td>0.1 (1)</td>
<td>0.6 (6)</td>
<td>0.2 (1)</td>
<td>0.5 (1)</td>
<td>8.8 (2,747)</td>
</tr>
<tr>
<td>Rainwater</td>
<td>2.5 (385)</td>
<td>7.1 (809)</td>
<td>27.5 (392)</td>
<td>3.2 (38)</td>
<td>23.7 (226)</td>
<td>53.2 (294)</td>
<td>10.5 (20)</td>
<td>6.9 (2,164)</td>
</tr>
<tr>
<td>Well water</td>
<td>0.2 (31)</td>
<td>1.0 (114)</td>
<td>24.9 (355)</td>
<td>0.2 (2)</td>
<td>7.0 (67)</td>
<td>0.2 (1)</td>
<td>2.1 (4)</td>
<td>1.8 (574)</td>
</tr>
<tr>
<td>Surface watera</td>
<td>0.2 (29)</td>
<td>0.8 (90)</td>
<td>1.1 (16)</td>
<td>0.3 (3)</td>
<td>39.2 (374)</td>
<td>0.4 (2)</td>
<td>6.3 (12)</td>
<td>1.7 (526)</td>
</tr>
<tr>
<td>Other</td>
<td>0.4 (63)</td>
<td>0.3 (37)</td>
<td>0.2 (3)</td>
<td>0.5 (6)</td>
<td>0.3 (3)</td>
<td>0.0 (0)</td>
<td>11.1 (21)</td>
<td>0.4 (133)</td>
</tr>
<tr>
<td>Totalc</td>
<td>49.6 (15,475)</td>
<td>36.7 (11,452)</td>
<td>4.6 (1,423)</td>
<td>3.8 (1,175)</td>
<td>3.1 (953)</td>
<td>1.8 (554)</td>
<td>0.6 (190)</td>
<td>100 (31,220)d</td>
</tr>
</tbody>
</table>

Data source: 2007 Demographic & Health Survey of the Dominican Republic.

aCan include spring/river/stream.

bSamples bolded are those collectively used in subsequent analysis.

c% for this row is for this row total (all other percentages are by column total).

dDue to rounding column total is 31,221 and row total is 31,222 rather than actual weighted sample size of 31,220.
bottled water use, i.e., externally purchased water housed in a bottle. Among those using tapped water as the principal non-drinking water source, 9.9% preferentially reported using trucked water as their principal drinking water source (Table 1).

**DISCUSSION**

Many Dominican households reported a substantial role for bottled water use for drinking water purposes despite relatively high levels of access to tapped water. An even higher level of bottled water use (66.9%), as the primary drinking water source for households, was found in a more recent national survey (2012) of the DR (Encuesta Nacional de Hogares de Propósitos Múltiples [ENHOGAR]) (Oficina Nacional de Estadística 2013). This high-bottled water use, at least within the DHS-DR study, was related to all hypothesized variables, although the measure of economic status explained the majority of variance in bottled water use within this analysis.

The strong positive relationship between higher wealth and bottled water use contrasts with the lack of a clear...
A qualitative study of bottled water use in Brazil identified a key role for women in decision-making around drinking water (Matos de Queiroz et al. 2013). Female head-of-household status retained only a borderline statistically positive relationship in the multivariate analysis within this study. This may relate to the apparent minimal relationship with having a small child in the household as it is thought that female head-of-household status may be biased towards strategies thought to benefit child health. Alternatively, there is some indication that different definitions of female-headed households may influence various relationships with child care indicators (Rogers 1996).

Younger age and higher levels of education of the head-of-household demonstrated the anticipated relationship with bottled water use. Younger age, though not educational level, was also related to bottled water use in a study in the USA (Hu et al. 2011). Perhaps this relates to older respondents having grown up during a time when bottled water was not available or regularly consumed.

As most households in this study sample had access to a tapped water source, and this source was frequently utilized for non-drinking water purposes, use of bottled water may be seen as a ‘choice’ in this context, rather than not having alternative water source access as in some other LMICs. For example, in the Ghanaian study of water sachet use cited previously, many households did not have tapped water to their house or compound (Stoler et al. 2012) as would be the case in other LMICs with lower standards of living than the DR. In the situation where there is choice, choice may be driven by beliefs and experiences with different water types. Lack of confidence in piped water quality has been raised as a key reason for high levels of bottled water use in the DR (Severino 2007). This mistrust may have some justification given findings from a recent study in the DR which found 47% of samples drawn from ‘improved’ drinking water sources to have a rating of high to very-high risk based on levels of *E. coli* (Baum et al. 2014).

### Table 3 | Logistic regression of predictors of bottled water use (non-weighted)

<table>
<thead>
<tr>
<th>Category</th>
<th>Variable/level</th>
<th>Exp (B) (95% CI)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Household characteristics</td>
<td>Wealth*</td>
<td>4.33 (3.95, 4.76)**</td>
</tr>
<tr>
<td></td>
<td>Poor</td>
<td>9.76 (8.79, 10.84)**</td>
</tr>
<tr>
<td></td>
<td>Middle</td>
<td>23.21 (20.43, 26.37)**</td>
</tr>
<tr>
<td></td>
<td>Richer</td>
<td>37.50 (31.80, 44.22)**</td>
</tr>
<tr>
<td></td>
<td>Child under 5 years of age in household</td>
<td>1.20 (1.10, 1.31)**</td>
</tr>
<tr>
<td>Place of residenceb</td>
<td>Town</td>
<td>1.66 (1.53, 1.80)**</td>
</tr>
<tr>
<td></td>
<td>Small city</td>
<td>1.36 (1.24, 1.50)**</td>
</tr>
<tr>
<td></td>
<td>Large city</td>
<td>2.35 (2.01, 2.73)**</td>
</tr>
<tr>
<td></td>
<td>Number of household members</td>
<td>0.85 (0.83, 0.87)**</td>
</tr>
<tr>
<td>Head-of-household characteristics</td>
<td>Gender (female)</td>
<td>1.09 (1.01, 1.17)*</td>
</tr>
<tr>
<td></td>
<td>Educational levelc</td>
<td>1.48 (1.31, 1.66)**</td>
</tr>
<tr>
<td></td>
<td>Primary</td>
<td>2.38 (2.07, 2.75)**</td>
</tr>
<tr>
<td></td>
<td>Secondary</td>
<td>2.02 (1.69, 2.40)**</td>
</tr>
<tr>
<td></td>
<td>Post-secondary</td>
<td>0.99 (0.99, 0.99)**</td>
</tr>
</tbody>
</table>

Data source: 2007 Demographic & Health Survey of the Dominican Republic.
*Reference category: poorest.
**Reference category: countryside.
Reference category: no education.
*p < 0.05.
**p < 0.001.

relationship found within the US studies cited in the introduction. This was expected and may be a function of the greater levels of absolute poverty in this LMIC resulting in reduced purchasing options for poorer households. Nevertheless, bottled water use substantially penetrated households with lower economic status in this country. From the full DHS-DR dataset, 21.7% of the poorest quintile households identified bottled water as their primary drinking source. An even higher usage level for this quintile was found in the more recent ENHOGAR 2012 study at 39.1% (Oficina Nacional de Estadística 2013).

The impact of having a young child in the household had only a small relationship with bottled water use. Unfortunately, the DHS dataset had only a single question that asked a general household level drinking water use question vs. use by specific household members so it is not possible to determine whether within the household there is variance in the principal drinking water source for children. There is some evidence that drinking water practice may vary by age, at least within the narrow age band of under 5 years of age in the DR (McLennan & Farrelly 2010). Also not captured in the DHS data is the practice for some households in the DR to purchase expensive one-gallon bottles of mineralized water from pharmacies that is marketed specifically for infants. In a follow-up qualitative component of the above cited Ghanaian study, some households gave sachet water to infants (Stoler et al. 2012).

As most households in this study sample had access to a tapped water source, and this source was frequently utilized for non-drinking water purposes, use of bottled water may be seen as a ‘choice’ in this context, rather than not having alternative water source access as in some other LMICs. For example, in the Ghanaian study of water sachet use cited previously, many households did not have tapped water to their house or compound (Stoler et al. 2012) as would be the case in other LMICs with lower standards of living than the DR. In the situation where there is choice, choice may be driven by beliefs and experiences with different water types. Lack of confidence in piped water quality has been raised as a key reason for high levels of bottled water use in the DR (Severino 2007). This mistrust may have some justification given findings from a recent study in the DR which found 47% of samples drawn from ‘improved’ drinking water sources to have a rating of high to very-high risk based on levels of *E. coli* (Baum et al. 2014).
There are several limitations to this study. First, the findings are based on data that was collected in 2007 and may not capture more contemporary changes. As noted above, data from ENHOGAR 2012 found even higher levels of bottled water use, although this may not change the relationship with the investigated predictor variables. Second, the DHS survey did not include additional questions that may have further fleshed out drinking water patterns in greater detail. This could have included questions to determine the frequency and exclusivity of the ‘principal’ drinking water sources given that households may not exclusively use only one source. A previous report from the DR identified a mix of drinking water types at the individual level, at least for young children (McLennan & Farrelly 2010).

Another limitation is the lack of availability of questions in the DHS survey that asked about respondent’s perceptions of water quality from different sources. Inclusion of questions as to the reasons for using a given principal drinking water source, or more specifically the reasons for choosing bottled over tap, may also have been informative. It would also have been useful to explore respondents’ perceptions of the viability of other strategies for improving drinking water safety, such as the addition of chlorine at the household level to tapped water (Mintz et al. 2001), as an alternative to purchasing bottled water.

Investigations in other countries have identified consumer factors such as organoleptic properties (e.g., taste, colour, odour), perceived tap water risks, and perceived health benefits, as seemingly influential factors in bottled water selection (Doria 2006; Doria et al. 2009; Gorelick et al. 2011; Hu et al. 2011; Matos de Queiroz et al. 2013). These factors may significantly influence behaviour across socio-economic status strata. As well, there have been economic evaluations of bottled water use in which there has been an attempt to tease out ‘defensive spending’ (i.e., to reduce perceived health risks) from non-health reasons (e.g., convenience) (Abrahams et al. 2000; Dupont & Jahan 2012).

An additional factor not examined in this study is the inconsistent delivery of water to many Dominican neighbourhoods and households that do have piped water. At times there is no or inadequate water pressure in which case the purchase of bottled water (or trucked water) may be less about choice and rather a requirement if the household supply of stored water runs low and there is no water in the piped water system. In the study of water sachet use in urban slums in Ghana, it was found that higher use was related to greater water rationing by those responsible for piped water delivery (Stoler et al. 2012). Unfortunately, the DHS questionnaire did not cover this phenomenon.

Finally, this paper does not address concerns about the safety of bottled water nor whether this practice is a desirable strategy. Other studies have begun investigating issues of safety of bottled water in other LMIC settings (e.g., Kassenga 2007; Oyelude & Ahenkorah 2012; Timilshina et al. 2012). However, further work is required particularly in settings where there may be gaps in quality monitoring. Stoler et al. (2012) suggested that use of water sachets in urban Ghana may have some legitimate role under the current conditions where some households do not otherwise have access to sufficient acceptable drinking water. Of concern, however, is whether such reliance might reduce pressure to expand and improve public water delivery.

**CONCLUSIONS**

That bottled water appears to be the primary drinking source for the majority of Dominicans is striking and may have implications in health, economic, and environmental domains. While the finding of higher use with higher economic status is not surprising, the extent of use by lower-income households is. The hypothesized predictor variables, beyond wealth, explained little variance in this practice suggesting such factors, at least those considered in this study, may not be particularly informative in understanding bottled water use. As other studies have found explanatory power from variables tapping perceptions and beliefs, it would be valuable for such variables to be incorporated in future large nationally representative surveys, such as the Demographic and Healthy Surveys, to better examine this expanding practice about such a critical issue as drinking water. Complementing this would be more systematic efforts in identifying safety of water derived from different drinking water sources. While costs are a barrier, pilot efforts are reported to be underway (UNICEF & WHO 2012) and may be an important gain for the consumer. Whether and how bottled water should be considered relative to ‘sustainable’, ‘improved’ drinking water sources in future development goal initiatives remains to be seen.
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