

Evaluating the Dietary and Nutritional Apps in the Google Play Store

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Objectives: The objective of this study was to evaluate the features of diet and nutrition apps available in the Google Play Store. **Methods:** A search was conducted in August 2017 using the Google Play Store database to identify apps related to diet and nutrition. Terms entered into the app search engine included 'diet apps' and 'nutrition apps'. The first 50 apps resulting from each search term was assessed. Duplicates were removed, and a comparative analysis was performed on the remaining diet and nutrition apps. **Results:** A total of 86 diet and nutrition apps were identified. One hundred percent (n = 86) of the apps retrieved were freely available. More than half of the apps were applicable to a target user group of all ages (94%, n = 81). Stratified analysis across unique diet and nutrition apps (total, n = 72) showed a higher average rating for the diet apps (4.4) in comparison to that for the nutrition apps (4.3). Diet apps were more likely to be recently updated than the nutrition apps (72% vs. 66%), and diet apps were more likely to feature app purchase than nutrition apps (36% vs. 19%). The average rating was slightly higher for diet apps not featuring in-app purchases, but ratings were similar for the nutrition apps. **Conclusions:** A centralized resource is needed that can provide information on health-related apps to allow for systematic evaluation of their effectiveness. Further research needs to examine improved methods of designing app-store platforms and presenting the available apps to properly guide users in app selection.

Keywords: Diet, Food, and Nutrition, Smartphone, Mobile Applications, Consumer Health Information, Evaluation Studies

I. Introduction

There has been a continuous expansion of mobile health (mHealth) in recent years; mHealth is a growing area that

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holds potential to deliver health-related behavior change interventions [1]. There are more than 100,000 apps falling into health, fitness, or medical categories [2]. Smartphone users are able to download applications or 'apps' to their devices [2]. Apps are self-contained programs for smartphones designed to fulfil a particular purpose. A mobile app is a software application developed specifically for use on small, wireless computing devices, such as smartphones and tablets, rather than desktop or laptop computers [2]. About 58% of adults in the US own smartphones, and 47% of those with household incomes less than \$30,000 have smartphones [3]. Health and fitness apps have great potential to reach populations with limited access to healthcare information and interventions. Smartphone apps have the capacity to facilitate behavior change [2]. The apps that have been associated with greater effectiveness provide interventions that include goal-setting, incorporate evidence-based behavior change tech-

niques, self-monitoring, and individually tailored feedback, and provide periodic summaries [4]. Other important features of a good health and fitness app include a user-friendly interface; a free trial version; easy initiation; availability of expert consultation; the ability to sync with other health and fitness apps, devices, and computers to allow easy review and sharing of statistics; as well as support for social networking [4]. Despite the recent proliferation of apps to promote positive lifestyle changes, there is a dearth of research evidence regarding their effectiveness [1].

Diet modifications and energy restriction, along with healthy lifestyle changes, have been recommended as the most effective interventions to prevent illness and manage the growing burden of chronic conditions [5]. A plethora of studies have assessed the role of diet monitoring for chronic disease management, using smartphone apps. Many methods exist for acquiring diet data; however, the process remains a challenge. Some common methods include 24-hour recall, food frequency questionnaires, and food records [6]. However, obstacles in dietary data collection make it difficult to accurately measure diet and nutrient consumption. These include reliance on accurate recall, lack of consistency in reporting, and the burden of diet recording [6]. However, with the rise of diet and nutrition apps, patients now have the ability to input their food consumption into their phones. App technologies allows patients to more easily monitor their caloric intake and dietary patterns to aid in weight and disease management. Innovative technology has been introduced to improve the accuracy of data collection and analysis, while reducing the burden on patients to record their own dietary habits [6]. Many apps include Internet-based dietary self-monitoring and online food databases to promote ease of recording, allowing easy individual dietary data collection and personal recording. These apps have been designed with many diverse features, including diet, weight, and physical activity tracking, the ability to communicate with physicians or registered dietitians, resource sections to learn more about specific diseases, community support forums providing the ability to chat with others who suffer from the same disease, camera and audio functions to facilitate digital dietary recording using object and voice recognition technology, progress updates and the ability to set goals, instant tailored feedback, and many more [6]. Some of these apps also include large food databases that users can search for food products to facilitate the diet recording process and have the ability to store common foods consumed.

Mobile app stores provide a unique platform for developers to rapidly deploy new updates of their apps [7]. Popular

mobile app stores include the Apple App store, Blackberry World Store, Google Play Store, and Microsoft Apps store. The app stores provide a wealth of information, including prices and customer reviews for apps [8]. The Google Play Store is a digital distribution outlet run by Google. In addition to apps, it sells other digital media, such as e-books, movies, and music. Purchased and free apps are available to download free of charge [9]. Purchased apps must be paid for before use, whereas free apps are available to download free of charge. Apps can be downloaded and updated manually or automatically from the app store [9]. The Google Play Store repository contains information of the most popular apps from the Google Play Store in the United States. Its webpages list the most popular and the newest released apps in each category based on their release dates and daily user usage [9]. There is not a centralized resource that collects information of all health-related apps for researchers to systematically evaluate the apps regarding their effectiveness and health outcomes [2]. The objective of this study was to conduct a comprehensive assessment of the various characteristics of diet and nutrition apps available in the Google Play Store. Diet and nutrition have been defined in various ways in the existing literature [5]. While diet refers to the sum of food consumed by a person, nutrition refers to nourishment at every level, including the ingestion and absorption of vitamins, minerals, essential amino acids, essential fatty acids from fat-containing food, and energy in the form of carbohydrate, protein, and fat. Hence, it encompasses more than simply eating a 'good' diet [5]. However, it is not clear whether there are differences in the design and impact of diet and nutrition apps in chronic disease management that may suggest the use of separate terminologies in the app store; hence, both diet and nutrition app categories were examined in this study. The findings of this study could provide relevant information to inform the design of future diet and nutrition apps, which have been shown to play a key role in chronic disease management. The Google Play Store was selected as our source of interest based on its popularity. The analysis of these available diet and nutrition apps could provide insights for future mHealth research and provide guidance for the development of mHealth apps dashboard that could assist consumers in the selection of apps based on their specific needs.

II. Methods

A search was conducted in August 2017 in the United States using the Google Play Store database to identify Android-

based mHealth apps related to diet and nutrition that are currently available on the market. Each app in the app store has its own homepage. The search was conducted on a desktop computer that was not logged into any user account and completed using the Internet Explorer browser. Search terms entered into the Google Play Store search window included: 'diet apps' and 'nutrition apps'. Apps were included that had received a rating of 4 or higher and were either free or purchased apps. Apps were excluded if their rating was below 4. In the initial search, 250 popular apps were displayed for each search term. The reason for categorizing our search terms by 'diet' and 'nutrition' was to identify whether differences exist in the app designs and functionality since these two terms are defined differently in the literature [5].

The first 50 apps listed for each search term, 'diet apps' (n = 50) and 'nutrition apps' (n = 50) were analyzed and evaluated in this review. The use of the first 50 apps identified in the search criteria was based on a prior study that showed that, in conducting Internet-based searches, the first 20 to 30 hits are the most reliable [10]. These apps were then further analyzed according to various criteria based on prior studies [6,7], including app name, company that created the app, user ratings and reviews, number of installations, whether the app was free or must be paid for, whether it featured advertisements, whether it had additional features that can be purchased within the app after it had been downloaded, the target user group or disease targeted by the app, the latest update the app had, and key highlights and features of the app that were easily displayed through headers or bold titles upon opening the app description.

1. Variable Extraction

The following variables were extracted from the search:

- Price: Information was gathered regarding whether the app is free or must be purchased.
- User group: Information was recorded about the target user group for whom the app was designed. The target user categories identified included everyone, everyone 10+, unrated.
- Advertisements: Information was gathered on whether the apps supported internal advertisements. Results were recorded as Yes or No.
- App purchases: Information was recorded on whether purchases could be made within the apps. Results were recorded as Yes or No.
- App updates: Information was recorded on the most recent year in which updates to the available apps were made.
- App ratings: Only apps having a rating of 4 and above were included and were further categorized into two groups based on ratings: 4 to 4.5 and higher than 4.5. The highest rating for apps on Google Play Store is 5. Our basis of choosing apps with a rating of 4 and above was to reflect the apps showing the highest user satisfaction rates.
- Number of raters: Information was recorded about the number of ratings the apps had received.
- Number of apps installed: Information was recorded about the number of times each app had been downloaded.
- App highlight categories: Information was recorded about the various features of the diet and nutrition apps available in the Google Play Store.

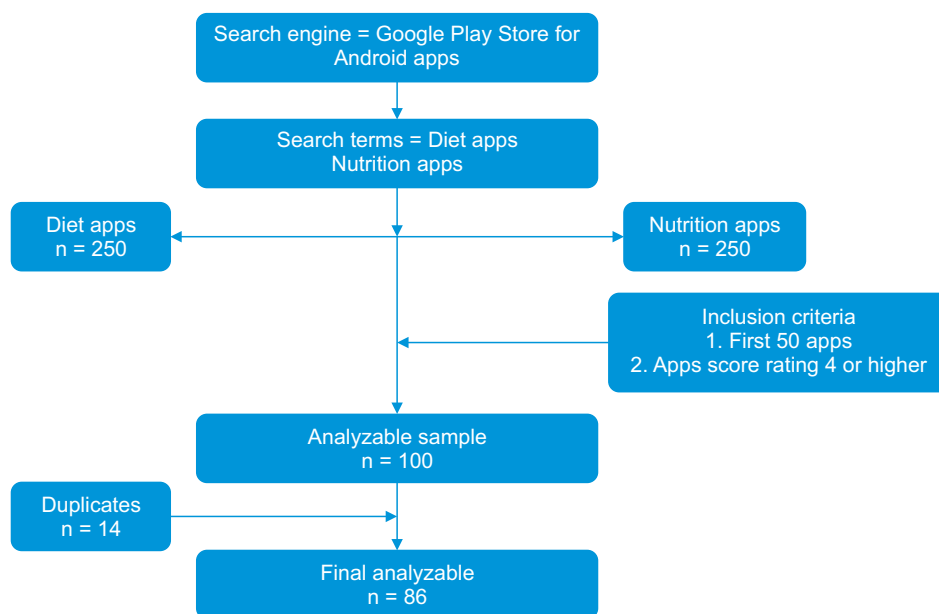


Figure 1. Search strategy for diet and nutrition apps in the Google Android Play Store.

Information was extracted from these apps to formulate the key findings regarding ease of comparing similar apps in the Google Play Store and the ability of these apps to successfully meet users' needs pertaining to their diet or nutrition related health goals.

2. Statistical Analysis

A descriptive analysis for the continuous and categorical variables was performed. The mean, median, and range were identified for the continuous variables, whereas percentage distributions were found for the categorical variables. Two raters (HS, AJ) evaluated the various features of the diet and nutrition apps. Correlation analysis was also performed to examine the relationship between the ratings and numbers of ratings for both diet and nutrition apps (Figure 1).

III. Results

A total of 86 diet and nutrition apps were included after the removal of duplicates. One hundred percent (n = 86) of the apps retrieved were freely available. Almost all apps were applicable to target users of all ages (94%, n = 81). Seventy percent of the apps featured advertisements within the apps (n = 60), and less than half of them (37%, n = 32) had provisions for in-app purchases.

The average rating for the overall apps was 4.4 (SD = 0.26), with a range of 3.9 to 5.0. Seventy-two percent of the apps (n = 62) had a rating between 4.0 and 4.5, and quarter of them had a rating greater than 4.5 (27%, n = 23). The mean number of raters providing these evaluations across the apps reviewed was 47,176 persons (SD = 190,076.78), with a range of 1 to 1,649,982. More than half of the apps had been updated in the year 2017 (56%, n = 48) (Table 1).

1. Stratified Analysis of Unique Diet and Nutrition Apps (n = 72)

The total numbers of diet and nutrition categories identified were compared (n = 86). Finally, a total of 72 unique apps including diet (n = 36) and nutrition (n = 36) apps were identified after the removal of similar apps across both categories (n = 14). The characteristics of the diet and nutrition apps were compared as follows:

- Based on ratings: The average rating of the diet apps (n = 36) was 4.4 in comparison to the average rating of 4.3 for the nutrition apps (n = 36). Similarly, the average number of ratings for the nutrition apps was much higher than that of the diet apps (29,091 vs. 22,394). The average range of installations for the nutrition apps was 5,000

to 10,000, which was much lower than the 100,000 to 500,000 range in both text and tables for the diet apps.

- Based on recent updates: Results showed that 49% (n = 35) of the diet or nutrition apps had been most recently updated in 2017. Approximately 26% (n = 36) of both the diet and nutrition apps had been most recently updated in 2015 or earlier. A comparative analysis of the diet and nutrition apps showed that more of the diet apps (72%, n = 26) had been recently updated in comparison to the nutrition apps (66%, n = 24).
- Based on target users: One hundred percent of the diet apps were targeted to everyone, as compared to 8% (n = 3)

Table 1. Featured characteristics of the identified apps from Google Play Store

| Variables assessed | Total apps |
|-----------------------|--|
| Price | |
| Free | 86 (100) |
| Target audience (age) | |
| Everyone | 81 (94) |
| Everyone 10+ | 2 (2) |
| Unrated | 3 (4) |
| Advertisements | |
| Yes | 60 (70) |
| No | 26 (30) |
| App purchases | |
| Yes | 32 (37) |
| No | 54 (63) |
| App updates | |
| 2012 | 2 (2) |
| 2013 | 3 (4) |
| 2014 | 6 (7) |
| 2015 | 11 (13) |
| 2016 | 16 (19) |
| 2017 | 48 (56) |
| Apps rating | 4.4 ± 0.26 4.4 (3.9–5.0) |
| Apps number of raters | 47,176 ± 190,076.78 1,041 (1–1,649,982) |
| Apps rating range | |
| <4.0 | 1 (1) |
| 4.0–4.5 | 62 (72) |
| >4.5 | 23 (27) |

Values are presented as number (%) or mean ± standard deviation or median (range).

of the nutrition apps that were unrated (Table 2).

- Based on advertisements: Similar percentages of diet (72%, n = 26) and nutrition apps (75%, n = 27) featured advertisements within the apps (Table 2).
- Based on app purchases: Diet apps tend to have much higher in-app purchase capabilities as compared to the nutrition apps (36% vs. 19%) (Table 2).

The average number of ratings, rating points, and number of installations were compared for the diet and nutrition apps. The results showed that in both categories, the average number of ratings was higher for those apps that offered in-app purchases (Table 3). The average rating was slightly higher for those diet apps that did not offer in-app purchases, but the ratings were similar for the nutrition apps. Similarly, the average ratings, when stratified by advertisements, were similar for the diet apps. However, for the nutrition apps, those apps that had advertisements within the apps had slightly higher ratings than those that did not have

advertisements (Table 3).

2. Analysis of Unique Diet and Nutrition Apps Stratified by Rating Categories

Results showed that 75% (n = 54) of the total apps (including both the diet and nutrition apps) had ratings in the range of 4.0 to 4.5, whereas 24% (n = 17) of the apps had ratings higher than 4.5. There was 1 app that had a rating below 4.0 even though an inclusion criteria was that an app must have a rating of at least 4.0. Results also showed that more than twice the number of diet apps (33%, n = 17) had ratings higher than 4.5 in comparison to the nutrition apps (14%, n = 5).

3. Most Common Features of Unique Diet and Nutrition Apps

Results showed that 69% of the diet apps had clearly categorized features, whereas less than half of the nutrition apps had a clear description of their features (36%, n = 13).

Twenty-five percent (n = 9) of the diet apps clearly mentioned the specific diet that the app was utilizing; whereas 94% (n = 34) of the nutrition apps did not mention any specific diet. Further, 17% (n = 9) of the diet apps had some description of a specific diet not categorized as a specific feature but that was mentioned in the description information related to that particular app. Those diet apps that did mention a specific diet included the military diet (n = 3), followed by the ketogenic diet (n = 2), and others including the 90-day diet (n = 1), the blood group diet (n = 1), the Atkins diet (n = 1) and the Paleo diet (n = 1). Education (33%, n = 12), planning (28%, n = 10), and tracking (22%, n = 8) were the most common features of the diet apps. Similarly, for the nutrition apps, education (31%, n = 11) and the use of food databases (19%, n = 7) were the most common features. Tracking, linking to social networks and receiving feedback,

Table 2. Comparison of diet and nutrition app characteristics

| Variables assessed | Diet apps (n = 36) | Nutrition apps (n = 36) |
|--------------------|--------------------|-------------------------|
| Audience | | |
| Everyone | 36 (100) | 31 (86) |
| Everyone 10+ | - | 2 (6) |
| Unrated | - | 3 (8) |
| Advertisements | | |
| Yes | 26 (72) | 27 (75) |
| No | 10 (28) | 9 (25) |
| App purchases | | |
| Yes | 13 (36) | 7 (19) |
| No | 23 (64) | 29 (81) |

Values are presented as number (%).

Table 3. Comparison of diet and nutrition app characteristics by in-app purchases and advertisements

| App characteristics | Diet apps (n = 36) | | | Nutrition apps (n = 36) | | |
|-------------------------|---------------------------|---------------|--------------------|---------------------------|---------------|-----------------------------------|
| | Average number of ratings | Rating scores | Number of installs | Average number of ratings | Rating scores | Number of installs (mode) |
| In-app purchases | | | | | | |
| Yes | 39,579 | 4.35 | 100,000–500,000 | 59,890 | 4.3 | 10,000–50,000 and 100,000–500,000 |
| No | 12,681 | 4.39 | 100,000–500,000 | 21,657 | 4.3 | 5,000–10,000 |
| Features advertisements | | | | | | |
| Yes | 22,695 | 4.38 | 100,000–500,000 | 19,672 | 4.3 | 100,000–500,000 |
| No | 21,611 | 4.38 | 100,000–500,000 | 57,346 | 4.1 | 10,000–50,000 |

Table 4. Comparison of features across diet and nutrition apps

| | Diet apps (n = 36) | Nutrition apps (n = 36) |
|------------------------|-----------------------|----------------------------|
| Categories defined | | |
| Yes | 25 (69) | 13 (36) |
| No | 11 (31) | 23 (64) |
| Specific diet | | |
| Yes | 9 (25) | 2 (6) |
| No | 21 (58) | 34 (94) |
| No title | 6 (17) | |
| Features | | |
| Education | 12 (33) | 11 (31) |
| Planning | 10 (28) | 3 (8) |
| Track | 8 (22) | 6 (16) |
| Reminder | 4 (11) | |
| Link to social network | 4 (11) | 6 (16) |
| Feedback | 6 (17) | 6 (16) |
| Privacy and security | 3 (8) | |
| Goal setting | 2 (6) | 1 (3) |
| Food database | | 7 (19) |

Values are presented as number (%).

were the other common features related to the nutrition apps (Table 4). Recipe planning was one of the most common planning features for both diet and nutrition apps. In addition, nutrition apps also provided features such as grocery lists ($n = 3$) and some behavioral assessment, including motivation, habits, and challenges ($n = 3$). Only one diet app specifically mentioned behavior assessment in its description. Results showed no association between the ratings and the number of ratings ($r = 0.18$, $p = 0.13$). Stratified analysis showed no association between the ratings and the number of ratings for the diet ($r = 0.22$, $p = 0.19$) or nutrition apps ($r = 0.17$, $p = 0.33$) (Table 4).

IV. Discussion

Empirical studies that have examined the utility and impact of diet- and nutrition-related apps for improving healthy eating, dietary tracking and weight-loss across diverse settings have focused on a wide range of target user groups, including ages 35 to 54 in Australia [11], 18 to 52 in the United Kingdom [6,12] and 18 to 65 in the United States [6]. The broad target user group was consistent with our findings, showing that 94% of diet and nutrition apps catered to users of all ages. Prior literature on interventions using diet and

nutrition apps have included both qualitative studies as well as randomized controlled trials [13]. Findings from these studies have shown that participants identified as effective diet and nutrition apps that were quick and easy to administer, as well as those that improved food-intake awareness and weight monitoring/management; such apps were highly preferred among study participants [13]. Significant findings were shown for the randomized controlled trials in enhancing dietary compliance for lower caloric and low-fat foods as well as high-fiber foods [13].

Our findings showed that the average ratings were slightly higher for diet apps that did not offer in-app purchases in comparison to those that offered in-app purchases; however, ratings were similar for the nutrition apps in both categories. Although our study only examined free apps (no cost), prior studies have shown that more expensive apps were more likely to receive higher ratings in terms of credibility and trustworthiness than those with negligible costs (91% vs. 86%, $p < 0.001$) [14]. In addition, apps exceeding \$0.99 were more likely to be used or recommended to patients than those costing less than \$0.99 (73% vs. 67%, $p < 0.001$) [14]. These findings suggest that cost may be an important factor affecting user satisfaction with diet and nutrition apps. Further research should be conducted to investigate this in depth. Our study findings also showed a higher proportion of advertisements in diet and nutrition apps (more than 70%) in comparison to prior studies assessing health and wellness apps in general (less than 20%) [15]. Advert-related transmissions were attributed to the presence of tracking codes included in web-based content downloaded within the apps, rather than the presence of tracking features in the actual apps [15]. Prior studies have also highlighted the risks of advertisement within apps due to its association with compromising privacy by allowing personal information to be sent to advertisers [15]. This raises a cause for concern in the design of nutrition apps, due to the high proportion of advert-friendly apps identified in the apps considered in our study (72% and 75%, respectively) as well as the relatively low proportion of diet apps having privacy and security features (3%) in our study.

Dietary tracking and education were the most commonly utilized features across diet and nutrition app interventions in the existing literature. This is consistent with our findings showing that education (diet apps, 33%; nutrition apps, 31%), diet and nutritional tracking (diet apps, 22%; nutrition apps, 16%), and food database (19%, $n = 7$) features were the most common features among the identified apps in our review. Prior studies have shown that these apps

utilize a variety of methods and functionalities that allow users to input their daily food records including food type and quantity, search for desired items in food databases, and produce graphical displays [13]. However, these studies also have highlighted the lack of culturally tailored and scientifically evaluated diet and nutritional apps for population groups with limited English speaking ability and poor health literacy [13]. In future research, there is a need for the development of apps that portray culturally relevant and tailored health messages to improve healthy eating behaviors and address the needs of broader population groups [13]. Reminders (11%, $n = 4$) and feedback (diet apps, 17%, $n = 6$; nutrition apps, 16%, $n = 6$) were some of the least commonly identified features across the diet and nutrition apps in this study. This is consistent with prior studies highlighting these features as some of the least identified across health and wellness apps (5%, $n = 4$) [16]. Nevertheless, empirical evidence suggests that reminders are an essential tool to sustain adherence to the use of health apps in general, and in particular, diet and nutrition apps, which require regular information tracking and data entry using food logs [16]. Further research should examine factors influencing the limited inclusion of these features across apps as well as design approaches to better incorporate them.

User reviews are a crucial component of open mobile app markets, such as the Google Play Store [17]. App stores provide a user feedback feature to rate apps with number of 'stars' and post a review message. Such feedback allows user-driven quality assessment and marketing. Applications with higher ratings also rank higher in 'top lists', which in turn increases an application's visibility and its download numbers [18]. Our study showed that 72% of the apps ($n = 62$) had a rating ranging between 4.0 and 4.5. However, the mechanism by which these ratings were estimated was not clearly specified on app platforms. While ratings and reviews add value to both the developer and potential new users by providing a crowd-sourced indicator of app quality, empirical studies have highlighted that relatively few diet and nutritional apps have been subjected to rigorous scientific testing and evaluations to assess their effectiveness in promoting health. Also, prior studies have highlighted that a majority of the evaluated apps lack the utility of evidence-based theories of health behavior change, such as reinforcement and evidence-based recommendations [19].

Mobile-app quality remains an issue of growing concern in health service delivery [20]. Mobile app stores continue to grow at a very rapid pace, with thousands of developers, and thousands of apps [7]. Our study's findings outline pre-

liminary features that are readily accessible when users are faced with making decisions on utilizing diet and nutrition apps. Such features play an important role in guiding users' choices, preferences, and ultimately the utility of such applications. Our study also identified limitations, including poor app-search engine optimization, inadequate information to guide users' decisions in obtaining diet and nutrition apps from electronic store platforms, such as Google Play Store, and the restriction to Google Play Store for identifying apps. In addition, limited evidence exists on evaluating the effectiveness of apps on the basis of user satisfaction or ratings. Further research should seek to develop improved methods of designing these app-store platforms, to improve their filter and feedback capacities, as well as incorporating evidence-based information to properly guide users' decisions in selecting diet and nutrition apps.

Conflict of Interest

No potential conflict of interest relevant to this article was reported.

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