

Free Diabetes Mobile Health Apps and Patient Survey: Is Medication Adherence a Concern?

Gloria Wu MD¹, Mary Rithu Varkey MBBS², Shannon Luu BS³, Brian Leung BS⁴, Kevin Lu BS⁵, Laura Billard BS⁶, Jaspreet Kaur MS⁷

¹University of California, San Francisco, School of Medicine; ²SRM Medical College Hospital and Research Center, Potheri, Kattankulathur, India; ³Santa Clara University; ⁴Tufts University; ⁵University of California, San Diego; ⁶University of California, Santa Barbara; Rowan University Graduate School of Biomedical Sciences, Glassboro, NJ

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Abstract

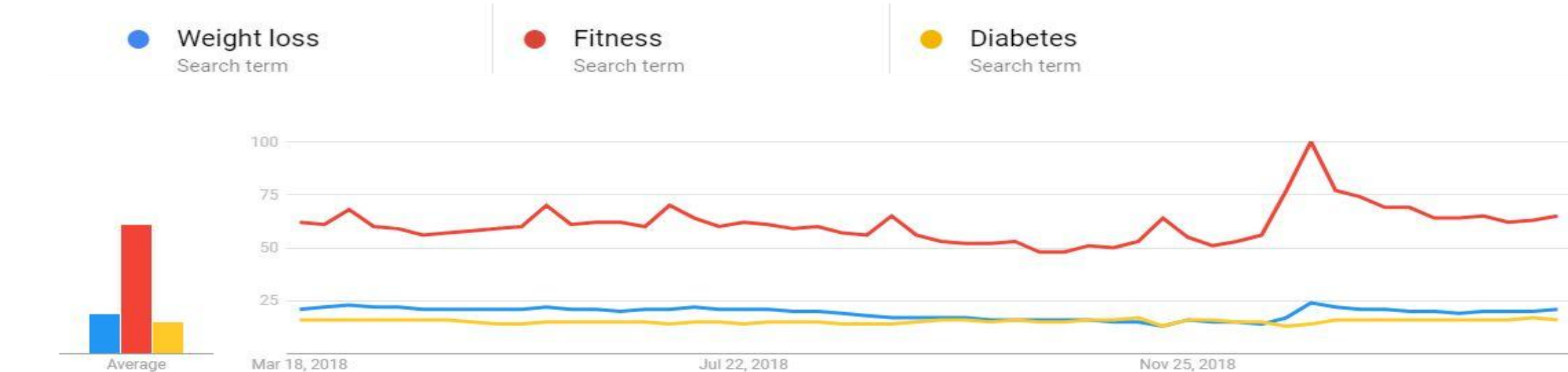
Background: Medication adherence is important in the management of diabetes. As there are 325,000 mobile health apps with 3.7B downloads in 2017. **Purpose:** To assess free diabetes mobile apps for adherence metrics and questionnaire(QN) to assess patient adherence and interest in apps. **Methods:**Google Play Store ranked the top 10 diabetes apps (DA) based on downloads. DA were distributed via MO offices, public places and internet (FB, Craigslist, Reddit). DA age, gender, education, Q1. Do you take your medication? Q2. Have you ever forgotten to take your medication? Q3. What lifestyle changes advised by your doctor would you adhere to? Q4. If you had a perfect reminder, it would be a) voice b)text c)your doctor's staff d)no reminder. Q5. When do you want to be reminded? Q6. Would you pay for a mobile app to remind you? Q7. Do you have diabetes. Q8. If yes, what type of diabetes? Q9. Do you have high blood pressure? **Results:** Top 10 DA had downloads of 1 x 10⁶ to 100K. 1)mySugr, 2)Onetouch Reveal, 3)OntrackDiabetes, 4)Diabetes Connect, 5)Health2Sync, 6)Diabetes, 7)Glucose Buddy, 8)DiabetesM, 9)Blood Glucose Tracker, 10)OneDrop Diabetes Management. 9/10 apps had push notification for reminders. Only 1 app, DiabetesM, fulfilled most of DSME criteria (calories, med log, HbA1c/FBS, stress, BP, Wt, Hb, DM, Exercise, Goals, Psych). 1/10 apps had rewards for compliance. No apps discussed HIPAA/privacy. Features: 9/10 weight; 8/10 HbA1c; 1/10 lipid; 7/10 exercise; 6/10 diet mgmt; 8/10 BP; 8/10 med list. None of the apps had psych/behavioral. Survey respondents(n)=1302; age range: 18-84 yrs, avg=40.5 yrs (sd 19.2). Females=67/Males=163. Education: college/post coll: 240(18.5%), HS and less: 52 (17.2%), For m=302. Q1(adherence) yes (Y) 252(83.4%),No 134 (3.3%), sometimes 37(12.5%), Q2 (non-adherence): Y 210(69.5%), No 92 (30.5%), Q3 (lifestyle changes): Weight 168 (55.6%), Exercise 237 (78.5%), Stress 152 (50.3%), Carb control 142 (47.0%), Won't change 18 (5.6%), Q4 (reminder): Voice 50 (16.6%), Text 203 (67.2%), Doctor's staff 6 (20.1%), No reminder 30 (9.9%), Q5 (frequency of reminder): cday 107 (35.4%), qwk 104 (34.4%), month 50 (16.6%), none 38 (12.9%), Q6 (pay for app): Y 51 (16.9%), No 248 (82.1%), Q7 (DA): Y 32 (10.0%), No 292 (89.9%), not know if diabetic: 8 (2.6%), Q8 (type of DA): type 1 =5(1.7%), Type 2=94(7.8%), gestational=2 (1.0%), No diabetes 262 (86.8%), not know if they have diabetes 9 (3.0%), Q9(HTN): Y 66 (21.9%), No 224 (74.2%),not know 12 (4.0%). **Conclusion:** Half of the apps address adherence, majority do not give rewards, or have all of DSME criteria. Most of the respondents were college educated, nondiabetic, would not pay for an app, and had forgotten to take their medications in the past. As MDs, we need to work with our pts to find the best, free apps for their diabetes medication adherence and diabetes management.

Background

- 325,000 mobile health apps with 3.7B downloads in 2017³
 - There are 256 apps in the Google Play Store for diabetes management
- Adherence improves patient outcomes and reduces cost of healthcare spending⁴
- DSMES (Diabetes Self-Management Education and Support) are the accepted standard guidelines for managing diabetic care
- Some important criteria for DSME/S are healthy diet, physical activity, medication usage, and healthy coping¹.

| Diabetes Self-Management Education/Support* supported by the ADA, ADA | |
|--|--|
| Definition: | |
| <ul style="list-style-type: none"> Diabetes Self-Management Education (DSME): The ongoing process of facilitating the knowledge, skill, and ability necessary for diabetes self-care. Diabetes Self-Management Support (DSMS): Activities that assist the person with diabetes in implementing and sustaining the behaviors needed to manage diabetes on an ongoing basis. ADA Standards of Medical Care <ul style="list-style-type: none"> All diabetic participants in DSME and DSMS at diagnosis and beyond <ul style="list-style-type: none"> An individualized medical nutrition program DSME/DSMS should be patient centered, respectful and responsive to individual patient preferences, needs, and values, could guide clinical decisions DSME/DSMS and medical nutrition therapy result in cost savings and improved outcomes DSME/DSMS and medical nutrition therapy reimbursed by third-party payers American Association of Diabetes Educators (AADE) has defined the AADE7 Self-Care Behaviors¹⁰ as a framework for patient centered diabetes self-management education (DSME) and care. <ul style="list-style-type: none"> Healthy Eating <ul style="list-style-type: none"> Being Active Monitoring Taking Medications Problem Solving Healthy Coping Reducing Risks The DSME/S Guiding Principles: <ul style="list-style-type: none"> Engagement <ul style="list-style-type: none"> Information sharing Psychological and behavioral support Integration with other therapies Coordination of care across specialty care, facility-based care, and community organizations Historically, DSME/S promulgated in hospitals and clinics. DSME/S methodology: inform/support patients via personal approach | |

Figure 1. Google Trends data for Google searches in US



Purpose

- To assess free diabetes mobile health apps for adherence metrics (healthy eating, being active, monitoring and using patient-generated health data, medications, treating chronic complications, healthy coping)
- Survey patient adherence and interest in compliance mobile apps using a public questionnaire

Methods

- Mobile Apps**
 - Used the search phrase "diabetes" in Google Play Store to find top Diabetes mobile health apps in 2018. Google Play Store ranked the top 10 diabetes apps based on number of installs
 - The top 10 diabetes apps were analyzed for features that support the DSME guidelines: 1)healthy eating, 2) being active, 3) monitoring, 4) taking medications, 5) treating chronic conditions, 6) healthy coping, 7) problem solving²

- Inclusion criteria:**
 - Mobile apps ≥ 100,000 installations
 - Featured logs/diary for diabetes management

- Exclusion Criteria:**
 - Mobile apps without available data on the number of installation

- Public Survey**
 - Created a questionnaire (Fig. 1). Posted survey on Craigslist, Facebook, Reddit. Uploaded to Craigslist monthly on their community bulletin board. Handed out surveys in medical offices, coffee shops and community colleges. Enrollment period 10/9/2018-present

- Inclusion Criteria:**
 - Participants ≥ 18 years old who agreed to the terms of participation, no compensation, and anonymity
 - Informed consent

- Statistical Analysis:**
 - Comparisons were made between male and female responses on the questionnaire using Pearson's Chi-squared test.
 - P < 0.05 was considered statistically significant.

Figure 1. Questionnaire

- Age
- Gender
- Ethnicity
- Education
- Do you take your meds when you are supposed to?
 - Yes
 - No
 - Sometimes
- Have you ever forgotten to take your medication?
 - Yes
 - No
 - I don't know
- What lifestyle changes advised by your doctor would you adhere to? Check all that apply.
 - Weight loss
 - Exercise
 - Carb intake
 - Stress Management
 - I will not change my lifestyle
- If you had a perfect reminder, it would be (check all that apply)
 - Voice
 - Text message
 - Doctor's staff
 - No reminder
- When do you want to be reminded?
 - 1x/day
 - 1x/week
 - 1x/month
 - No reminder
- Would you pay for a mobile app to remind you?
 - Yes
 - No
- Do you have diabetes?
 - Yes
 - No
 - I don't know
- If you have diabetes, which one do you have?
 - I don't have diabetes
 - Type I
 - Type II
 - Gestational
 - Other (LADA, MODY)
 - I don't know
- Do you have high blood pressure?
 - Yes
 - No
 - I don't know

Results

| Table 1. Top 10 Diabetes Apps: 2018 | | | | | | |
|-------------------------------------|-------------------------|-----------|------------------|------|--------------------------|--|
| Name | Developer | Installs | Category | Ads? | Offers in-app purchases? | |
| 1. mySugr | mySugr GmbH | 1,000,000 | Medical | Yes | Yes | |
| 2. Onetouch Reveal | Lifescan Europe | 1,000,000 | Medical | No | No | |
| 3. Ontrack Diabetes | Vertical Health | 500,000 | Medical | No | No | |
| 4. Diabetes Connect | SquareMed Software GmbH | 100,000 | Medical | No | Yes | |
| 5. Health2Sync - Diabetes Care | H2 Inc. | 100,000 | Medical | No | Yes | |
| 6. Diabetes | Klimaszewski Szymon | 100,000 | Medical | Yes | Yes | |
| 7. Glucose Buddy Diabetes Tracker | Azumio, Inc. | 100,000 | Medical | Yes | Yes | |
| 8. Diabetes.M | Sirma Medical Systems | 100,000 | Medical | Yes | Yes | |
| 9. Blood Glucose Tracker | Little Bytes Software | 100,000 | Health & Fitness | No | Yes | |
| 10. OneDrop Diabetes Management | One Drop | 100,000 | Health & Fitness | No | No | |

| Table 3. Diabetes Mobile Apps: 2018 Features | | | | | | | | |
|--|---------|-------------|----------|----------------|-------|-----------------|----------|-----------------|
| App | 1) Diet | 2) Exercise | 3) HbA1c | 4) Medications | 5) BP | 6) Stress Mngmt | 7) Goals | DSMES Crit (7)* |
| mySugr | X | X | X | X | X | | | 5/7 |
| Diabetes Connect | X | X | X | X | X | | | 5/7 |
| Health2Sync - Diabetes Care | X | X | X | X | X | | | 5/7 |
| Diabetes | X | | | X | | | | 2/7 |
| Glucose Buddy Diabetes Tracker | X | X | | X | X | | | 4/7 |
| Diabetes.M | X | X | X | X | X | | | 5/7 |
| Blood Glucose Tracker | X | X | X | X | X | | | 5/7 |
| Ontrack Diabetes | X | X | X | X | X | | | 5/7 |
| Onetouch Reveal | X | X | X | | X | | | 4/7 |
| OneDrop Diabetes Management | X | X | X | X | X | | | 5/7 |

*DSMES criteria¹ 1)healthy eating, 2) being active, 3) monitoring, 4) taking medications, 5) treating chronic conditions, 6) healthy coping, 7) problem solving

| Table 2. Top 10 Diabetes Apps: 2019 | | | | | | |
|-------------------------------------|-------------------------|-----------|------------------|------|--------------------------|--|
| Name | Developer | Installs | Category | Ads? | Offers in-app purchases? | |
| 1. mySugr | mySugr GmbH | 1,000,000 | Medical | Yes | Yes | |
| 2. Onetouch Reveal | Lifescan Europe | 1,000,000 | Medical | No | No | |
| 3. Ontrack Diabetes | Vertical Health | 500,000 | Medical | No | No | |
| 4. Diabetes.M | Sirma Medical Systems | 500,000 | Medical | Yes | Yes | |
| 5. Diabetes Connect | SquareMed Software GmbH | 100,000 | Medical | No | Yes | |
| 6. Health2Sync - Diabetes Care | H2 Inc. | 100,000 | Medical | No | Yes | |
| 7. Diabetes | Klimaszewski Szymon | 100,000 | Medical | Yes | Yes | |
| 8. Glucose Buddy Diabetes Tracker | Azumio, Inc. | 100,000 | Medical | Yes | Yes | |
| 9. Blood Glucose Tracker | Little Bytes Software | 100,000 | Health & Fitness | No | Yes | |
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| Table 3. Diabetes Mobile Apps: 2019 Features | | | | | | | | |
|--|---------|-------------|----------|----------------|-------|-----------------|----------|-----------------|
| App | 1) Diet | 2) Exercise | 3) HbA1c | 4) Medications | 5) BP | 6) Stress Mngmt | 7) Goals | DSMES Crit (7)* |
| mySugr | X | X | X | X | X | | | 5/7 |
| Diabetes Connect | X | X | X | X | X | | X | 6/7 |
| Health2Sync - Diabetes Care | X | X | X | X | X | | | 5/7 |
| Diabetes | X | | | X | | | | 2/7 |
| Glucose Buddy Diabetes Tracker | X | X | | X | X | | | 4/7 |
| Diabetes.M | X | X | X | X | X | | X | 6/7 |
| Blood Glucose Tracker | X | X | X | X | X | | | 5/7 |
| Ontrack Diabetes | X | X | X | X | X | | | 5/7 |
| Onetouch Reveal | X | X | X | | X | | | 4/7 |
| OneDrop Diabetes Management | X | X | X | X | X | | | 5/7 |

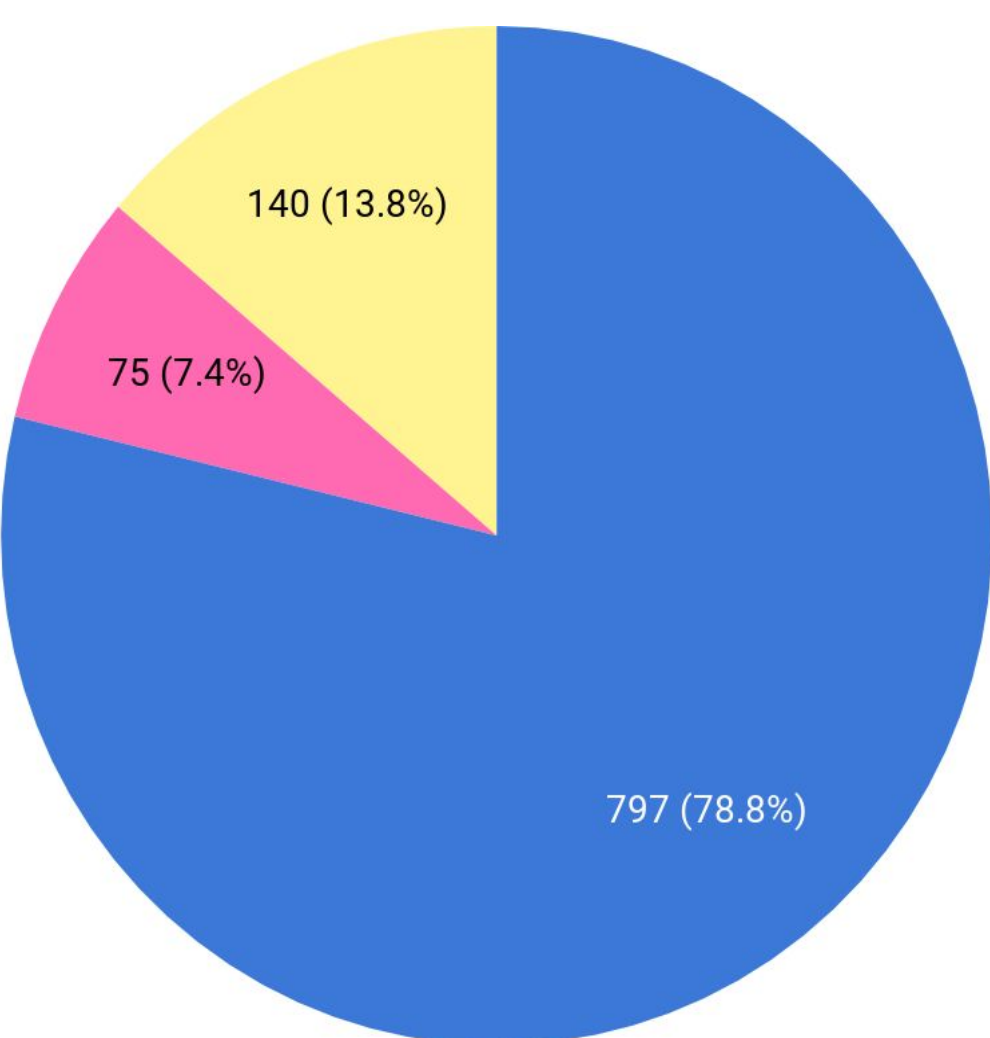
*DSMES criteria¹ 1)healthy eating, 2) being active, 3) monitoring, 4) taking medications, 5) treating chronic conditions, 6) healthy coping, 7) problem solving

Survey Results

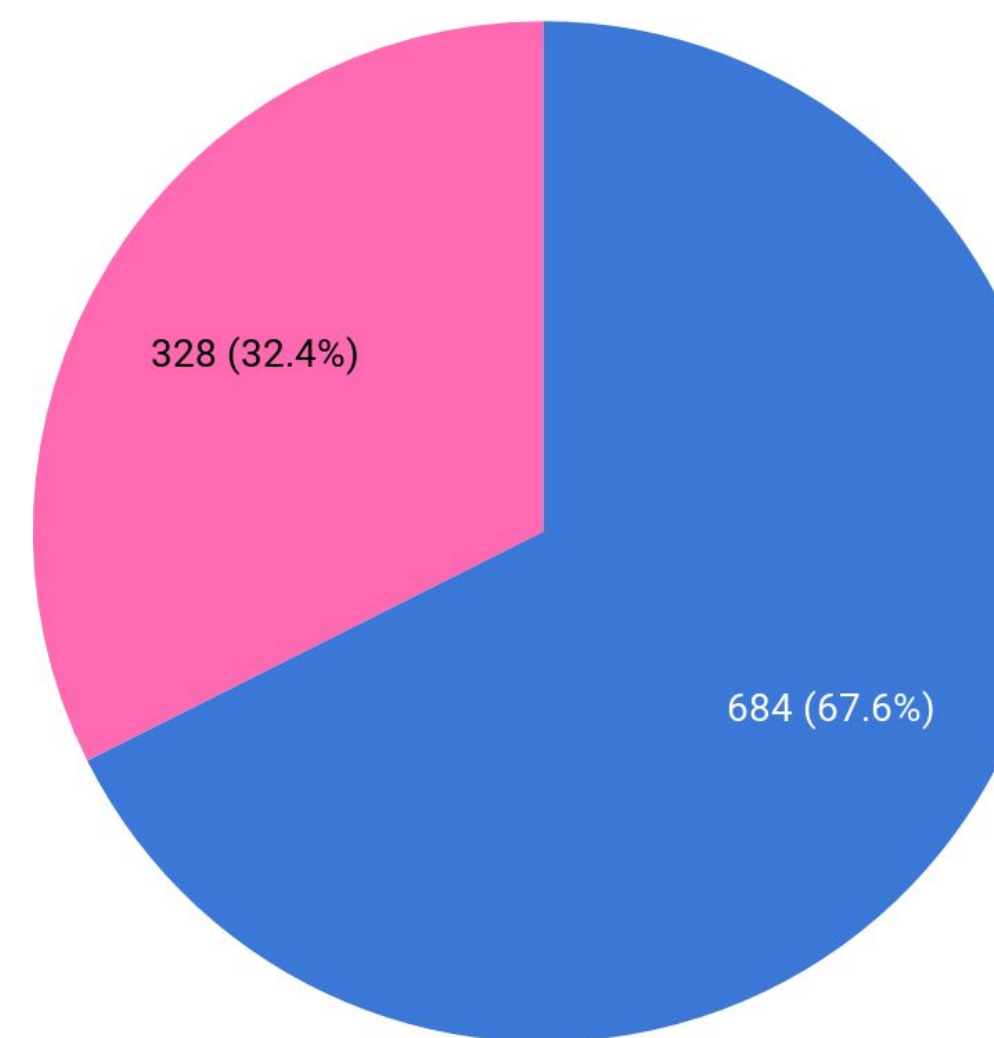
- n=1016 Responses, F = 564, M = 443, No gender = 8
- Avg age = 45.04 ± 19.10 yrs (18-94 yrs)
 - Female: Avg age = 44.05 ± 19.18 yrs (18-94 yrs)
 - Male: Avg age = 46.29 ± 19.18 yrs (18-88 yrs)

| Table 3. Demographics | |
|-------------------------------|--------|
| QN1. Age yrs (n=945) | |
| 18-29 | 31.85% |
| 30-49 | 25.71% |
| 50-65 | 26.98% |
| 65+ | 19.79% |
| QN2. Gender (n=1007) | |
| Female | 56.01% |
| Male | 43.90% |
| QN3. Ethnicity (n=951) | |
| Asian | 45.51% |
| Caucasian | 43.04% |
| Hispanic | 7.46% |
| African American | 3.99% |
| QN4. Education (n=980) | |
| <High School | 2.14% |
| High School | 11.63% |
| College | 52.24% |
| Postgraduate | 33.98% |

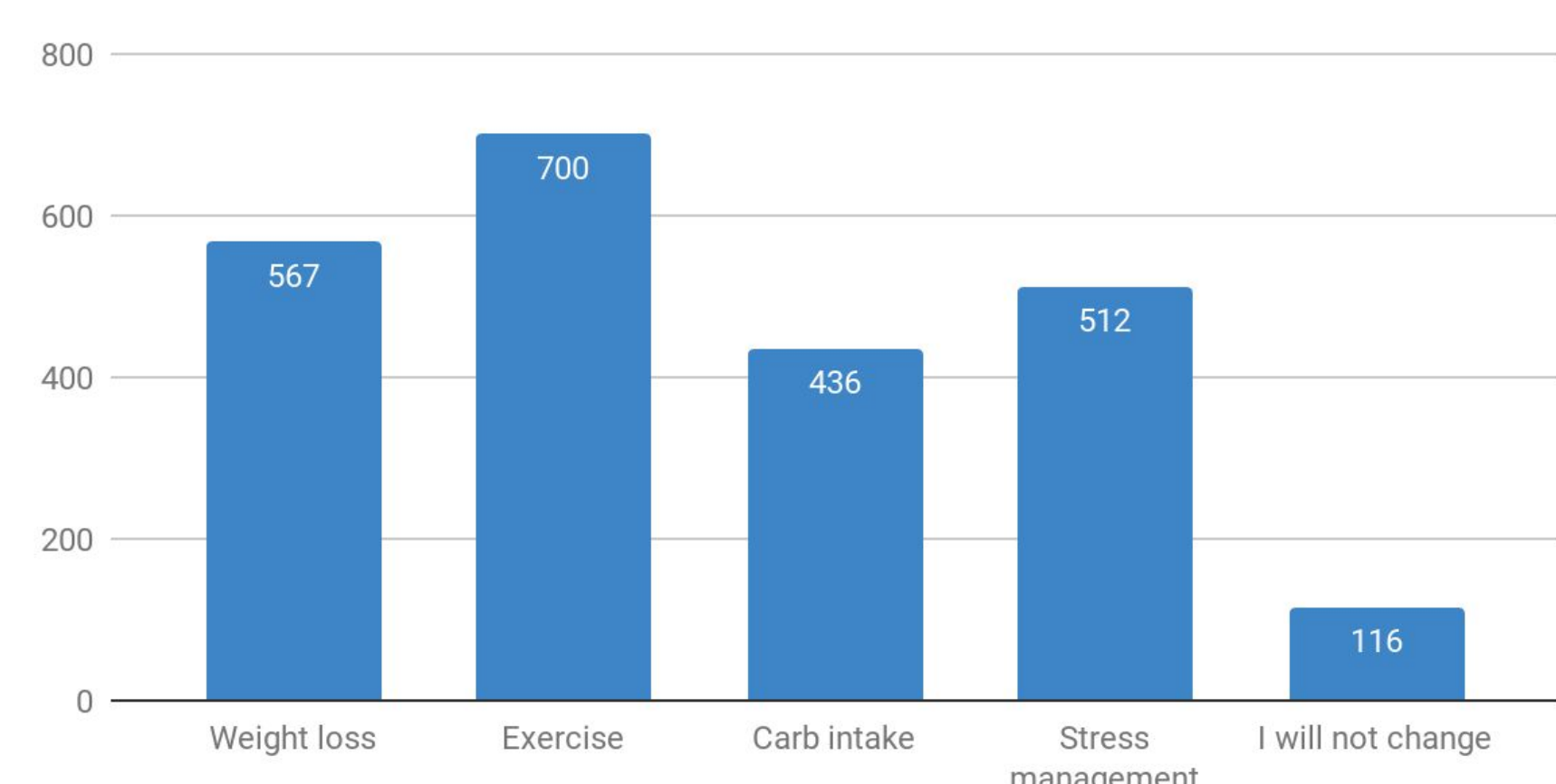
QN5. Do you take your medications when you are supposed to? (n=1012)



QN6. Have you ever forgotten to take your medications? (n=1012)



QN7. What lifestyle changes advised by your doctor would you adhere to? (n=1004)

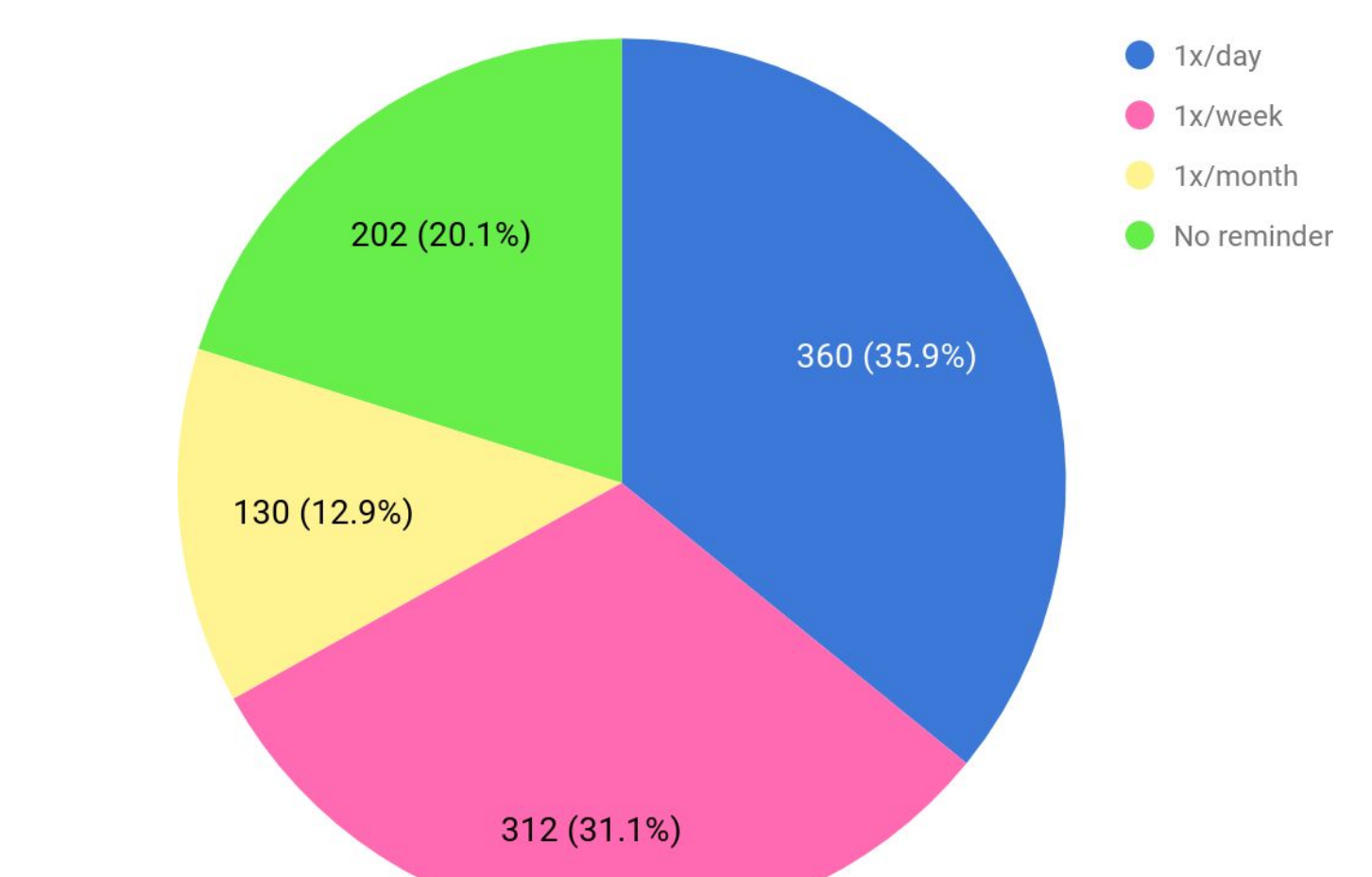


QN8. If you had a perfect reminder, it would be (n=1010)

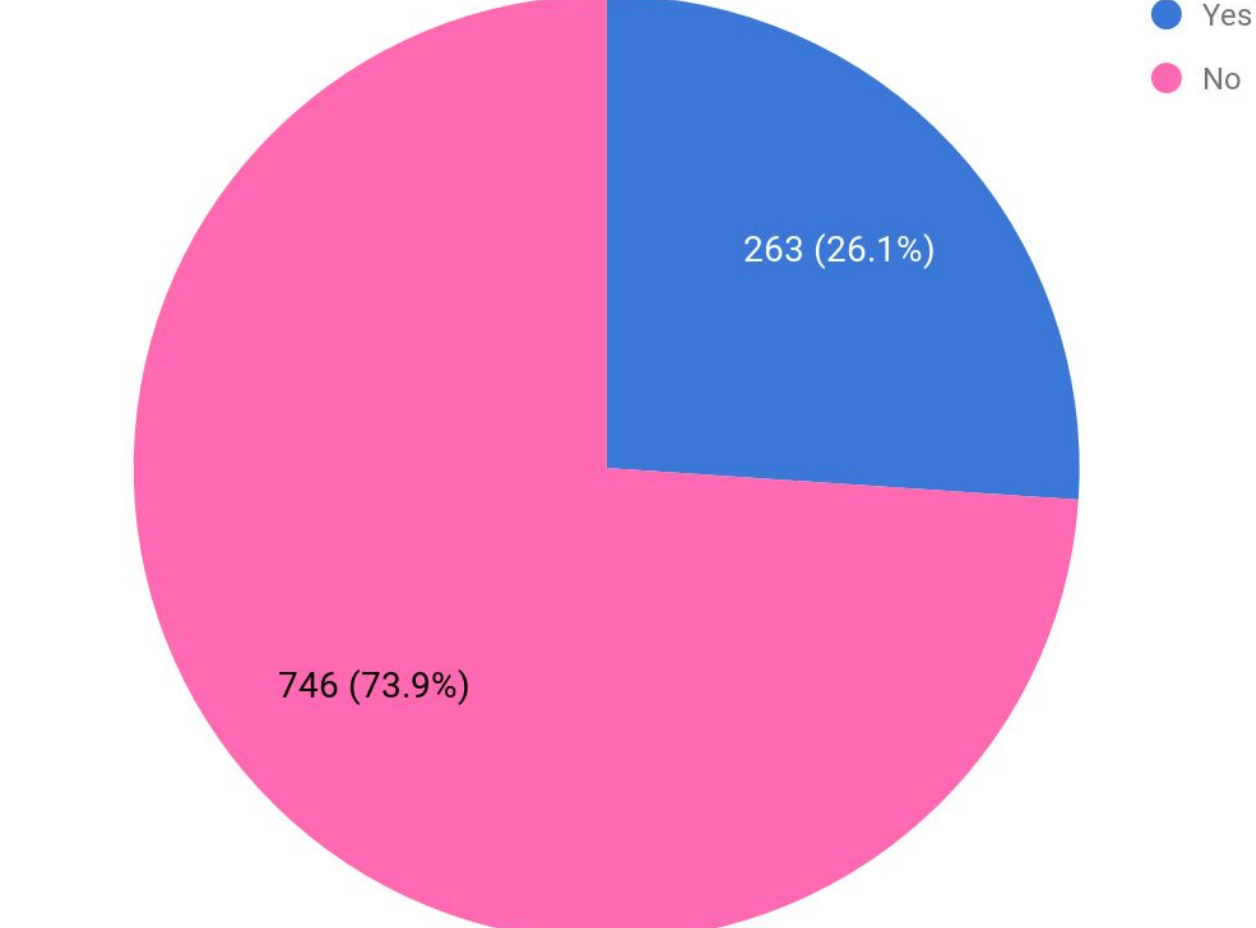


Results (cont.)

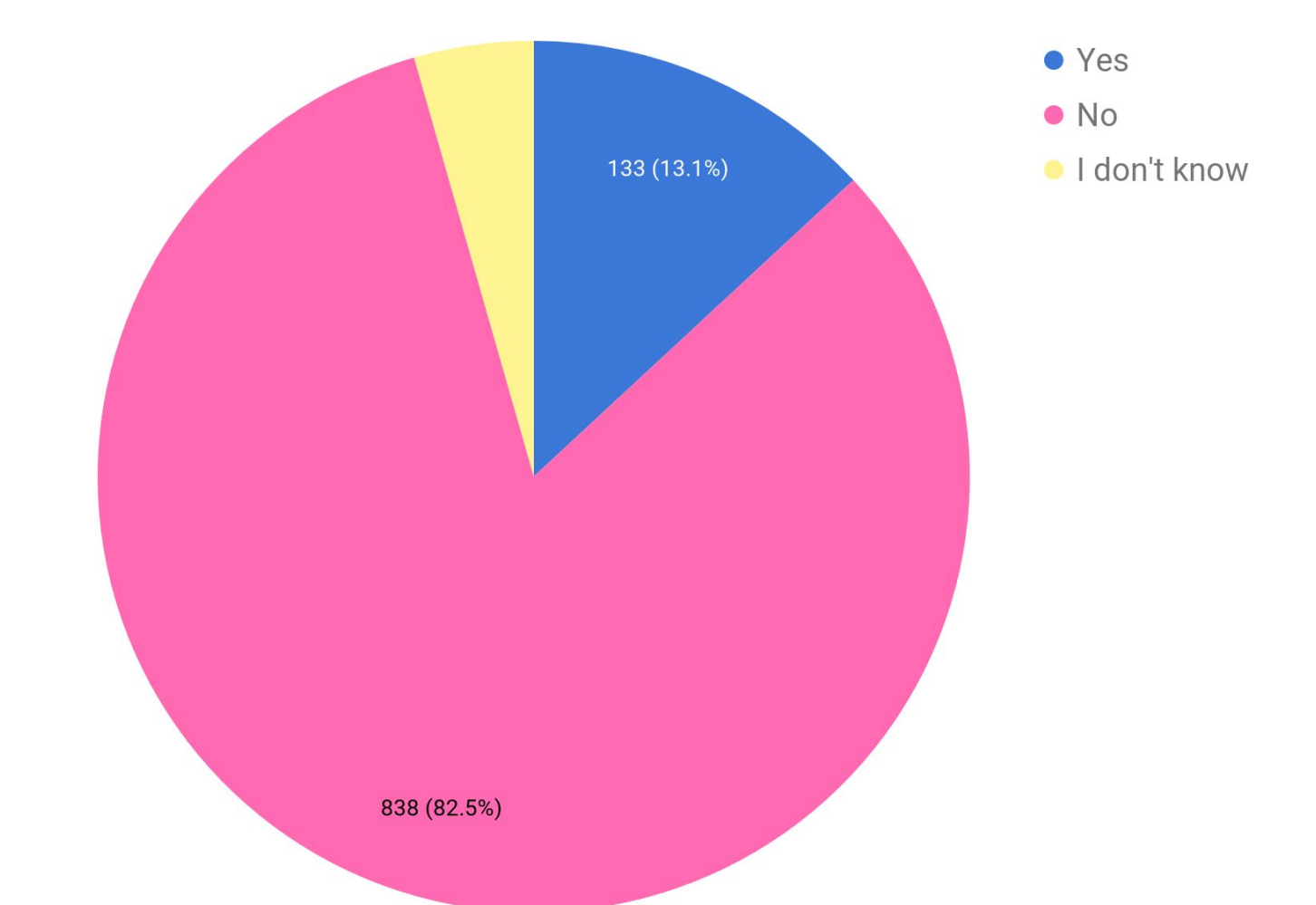
QN9. When do you want to be reminded? (n=1004)



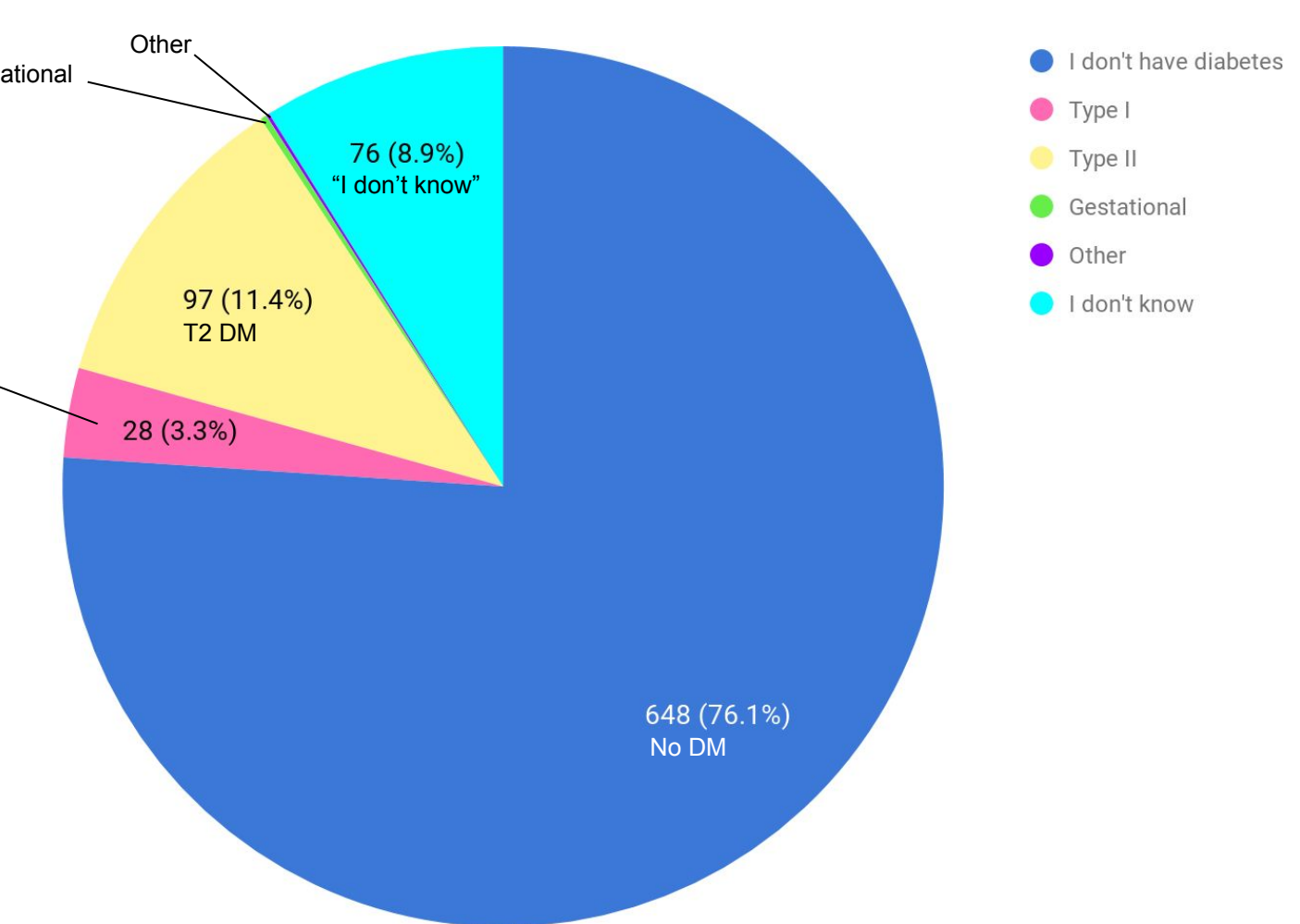
QN10. Would you pay for a mobile app to remind you? (n=1009)



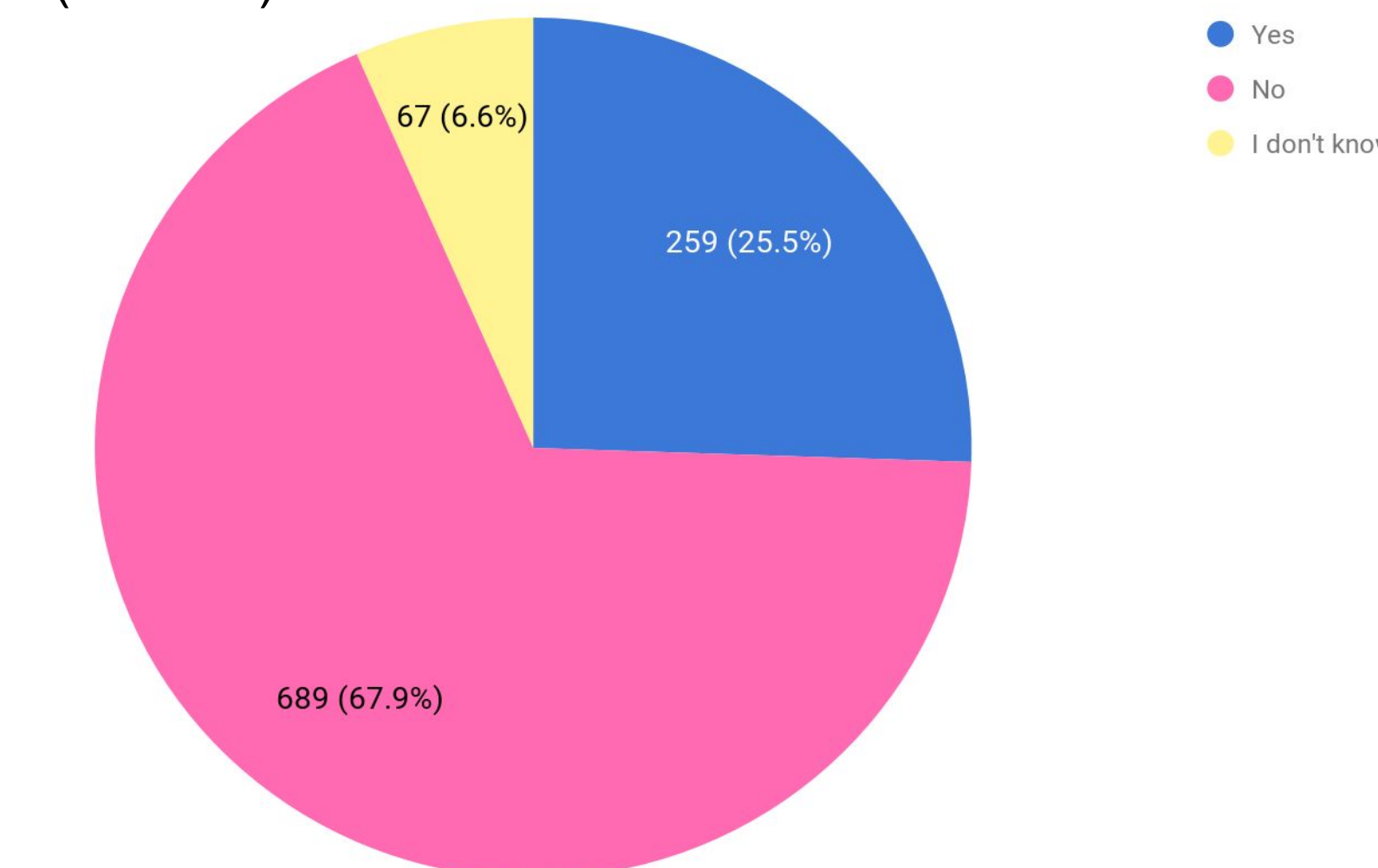
QN11. Do you have diabetes? (n=1014)



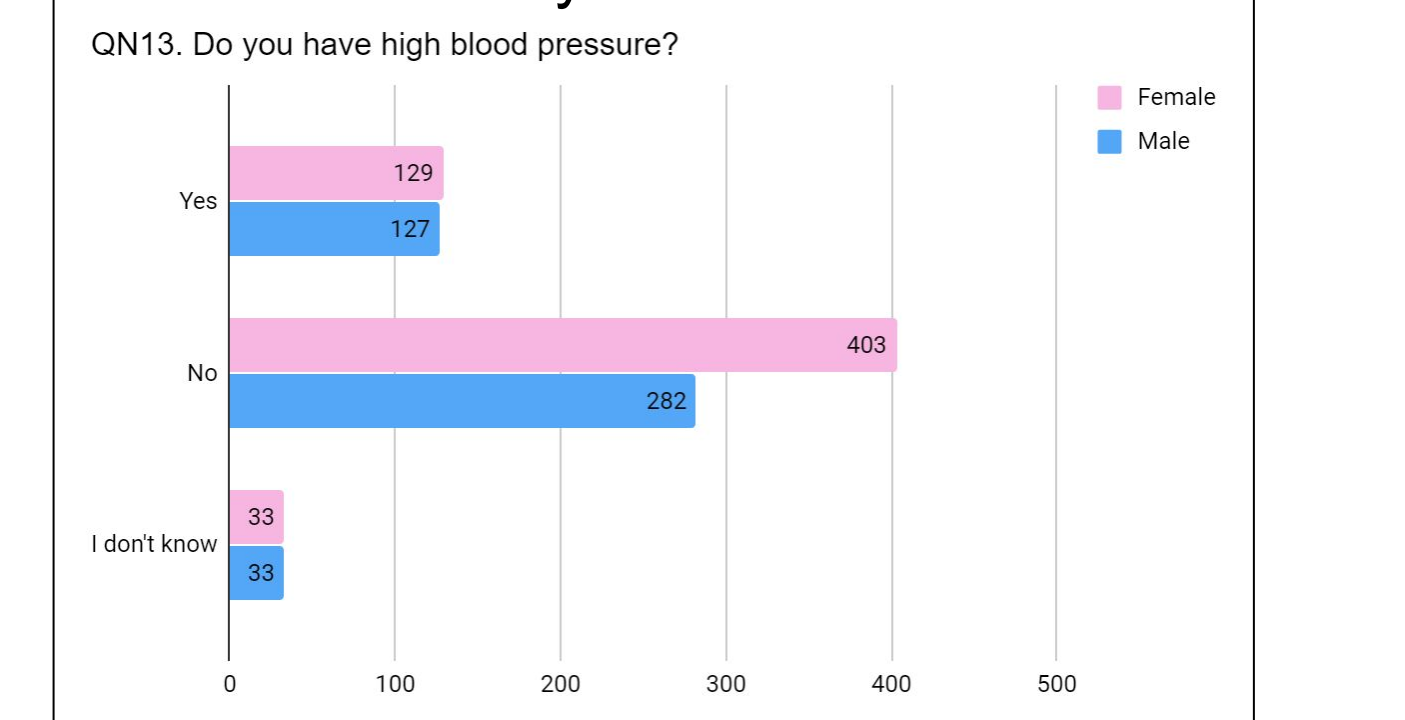
QN12. If you have diabetes, which type do you have? (n=852)



QN13. Do you have high blood pressure? (n=1015)



Subanalysis for QN13: Female v. Male



For QN5-13, female v. male responses were not statistically significant except for QN13.

$$\chi^2 = 6.46, df = 2, P = 0.040$$

Discussion

Mobile Apps

- All the apps lacked features for stress management.

Public Survey

- Some of the internet forums did not allow frequent postings e.g. Craigslist and Reddit, due to privacy settings
- Inherent bias in surveys posted on the internet
 - Internet usage increases with younger age, increased education (97% college graduate)⁵, increased income (more than 80% have income >\$30K/yr)⁵.
 - Female preponderance of respondents as more females access internet for health questions⁶

Conclusion

- The most popular diabetes mobile apps do not routinely include all of the 2018 DSMES criteria for diabetes management.
- In this public survey, the majority of respondents report nonadherence.
- As physicians, we need to continue our public education efforts about diabetes management and medication adherence.

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