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Using natural language processing (NLP) to understand self-reported barriers and enablers to treatment adherence in type 2 diabetes (T2D) using data from the International Diabetes Management Practices Study (IDMPS)

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INTRODUCTION

- Treatment non-adherence reduces the effectiveness of type 2 diabetes (T2D) therapy and is associated with poor glycemic control.[1]
- The factors contributing to reduced treatment adherence are not well understood in low-to-middle income countries (LMICs).

OBJECTIVE

To identify barriers to and enablers of treatment adherence as reported by people with T2D using data from the International Diabetes Management Practices Study (IDMPS).

METHODS

- IDMPS is an international, observational investigating real-world data on clinical profiles, disease management and patterns of care in people with diabetes living in LMICs.
- Data were collected in individual waves between 2005 and 2020. During each wave, physicians completed standardized case report forms for the first 5 adults with type 1 diabetes and 10 adults with T2D seen in clinical practice during a 2-week recruitment period.
- In the most recent wave of data collection (Wave 8, 2018–20), participants provided written responses to three open-ended, self-reported questions (Q) relating to therapy adherence:
  - Q1: If you tend to forget or skip your diabetes medication, could you explain the reasons why?
  - Q2: If you do not always take your diabetes medication as prescribed, could you explain the reasons why?
  - Q3: If you always take your medication as prescribed, could you explain how you make sure not to forget it?
- Natural Language Processing (NLP) and clustering methods were used to analyze responses **(Figure 1)** on omitting medications (Q1), not taking medications as prescribed (Q2), and methods to improve adherence (Q3), with Q1 and Q2 responses merged as reasons for 'omission'.

RESULTS

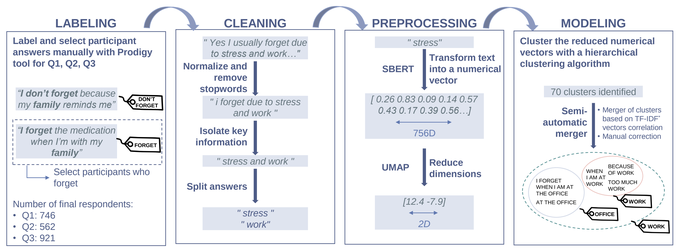
- This analysis included 2475 adults with T2D in 13 countries; baseline characteristics are shown in **Table 1.**
- Questionnaire response rate was high for Q1 (n=2101) and Q2 (n=1951) **(Figure 2)**, with 36% of respondents indicating that they were non-adherent (62% adherent, 2% uncertain).
- The most common reasons for forgetting/not adhering to treatment were related to personal schedules **(Figure 3)**, e.g., being out of their home, at work, or too busy.
- Participants remembered to take their medication by making it part of a routine **(Figure 3)**.
- Majority of the participants who used methods to remind treatment had set an alarm (n=79),used a pillbox (n=45) or reminder note (n=20) **(Figure 3)**.

Table 1: Baseline characteristics of participants

Baseline characteristics	N=2475
Age, years	58.0 ± 11.8
Sex, female, %	50.9
BMI at inclusion, kg/m^2	30.0 ± 5.6
HbA_{1c}, %	8.0 ± 1.8
Time since diabetes diagnosis, years	11.3 ± 8.3
Current T2D treatment, n (%)*	
OGLD	1309 (53.0)
Insulin + OGLD	824 (33.0)
Insulin alone	247 (10.0)
Macrovascular complications, n (%)†	191 (8.0)
Microvascular complications, n (%)†	521 (21.8)
Participation in structured diabetes education program, n (%)†	471 (60.9)

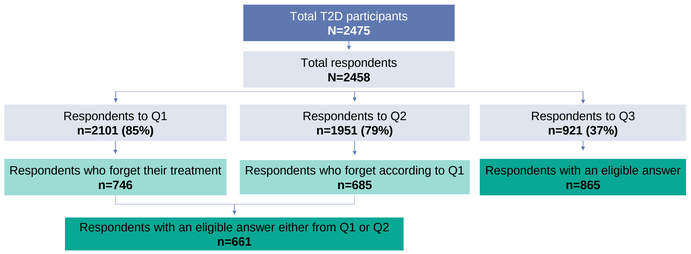
N=2475 are eligible population for cross-sectional phase. Data shown are mean ± SD unless stated otherwise.
*82 participants were treated with diet and exercise alone and 13 participants were receiving treatments other than OGLD, insulin, or diet and exercise. †N=2391 for participants with ≥1 microvascular complication or macrovascular complication, N=774 for participation in structured diabetes education program.
BMI, body mass index; HbA_{1c}, glycated hemoglobin; OGLD, oral glucose-lowering drugs; SD, standard deviation; T2D, type 2 diabetes.

Figure 1. Methodology overview



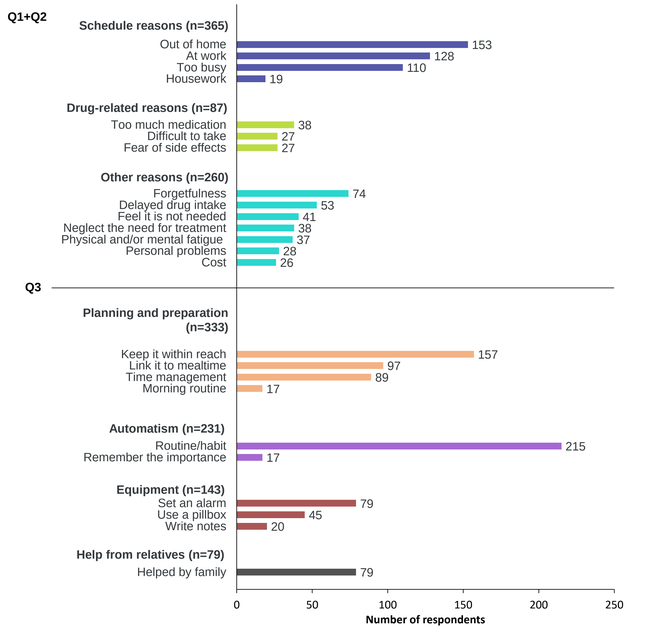
*TF-IDF gives the occurrence of a word in an answer weighted by its occurrence in other answers. SBERT is a programing framework and UMAP is an analytical tool for dimension reduction.
BERT, bidirectional encoder representations from transformers.
Q, question; SBERT, Sentence-BERT, TF-IDF, term frequency - inverse document frequency; UMAP, uniform manifold approximation and projection .

Figure 2. Participants and respondents per question



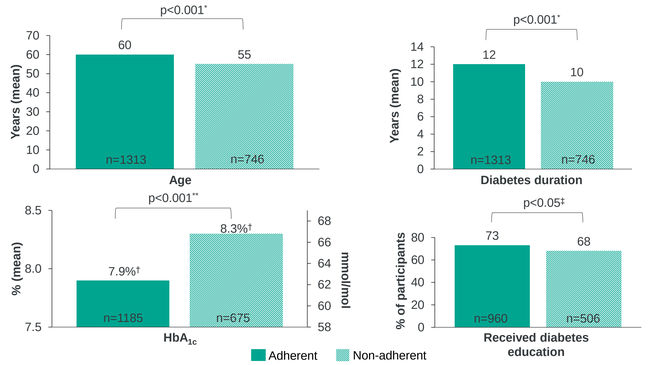
Q, question; T2D, type 2 diabetes.

Figure 3. Questionnaire topics and responses



A total of 746 people responded that they were non-adherent to their therapy (Q1+Q2), results shown are based on those who provided reasons for being non-adherent (n=661). A total of 921 participants responded to Q3, results shown are based on those who provided usable responses (n=865). Participants may belong to several clusters, as their answers could contain several topics.

Figure 4. Comparison of adherent and non-adherent respondents



*p-value of Wilcoxon rank-sum test; **p-value of Student t-test; †HbA_{1c} 7.9% = 63 mmol/mol and 8.3% = 67 mmol/mol; ‡p-value of chi-square test.

RESULTS (continued)

- On average, people with T2D with medication non-adherence were younger, had shorter diabetes duration and higher HbA_{1c} than those who were adherent (all p<0.001), and they were also less likely to have received diabetes education (p<0.05) **(Figure 4)**.

DISCUSSION

- Scheduling conflicts, burdensome regimens and fear of side-effects were identified as barriers to therapy adherence, which aligns with previous reports.[1–3]
- Establishing a routine and keeping medication nearby were reported as the main ways that people with T2D remain adherent to their treatments.
  - Tools such as a phone alarm, notebook, or pill box can provide physical reminders.
- In accordance with previous reports,[2,4] participants with medication non-adherence were younger, had shorter diabetes duration and higher HbA_{1c}, while diabetes education was associated with improved medication adherence.
- Closed versus open questions elicited different responses and participant responses did not always align with their physician's opinion (data not shown).

CONCLUSIONS

Conflicts with daily routine are the main barrier to therapy adherence, while planning and habit formation can improve adherence.

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DISCLOSURES

JCNC, JJG, HI, AR, JCM, MS, and PA are all members of the IDMPS steering committee and have received honoraria for travel grants and speakers' fees from Sanofi. JCNC has also received research grants and/or honoraria for consultancy or giving lectures from AstraZeneca, Bayer, Boehringer Ingelheim, Eli Lilly, Merck Serono, Merck Sharp & Dohme, Novartis, Pfizer and Sanofi. MR, MB and PH are employees of Quinten, contracted by Sanofi. J-MC is an employee of Sanofi and may hold Sanofi stocks/shares.