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Socio-Cultural Factors in Diabetes Care in South Korea

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In this study, the author reports findings and design outcomes from a 16-week healthcare design course led by two instructors in collaboration with medical experts at a tertiary medical institution. The research team investigated South Korean socio-cultural factors that adversely affect people's health and trigger diabetes onset: excessive working hours and drinking culture, social stigma and patients' hiding behaviours, and reliance on unverified information from online communities. The same factors also pose serious difficulties in diabetes patients' diet and exercise management. To address the problems, students proposed four design concepts: (1) a portable, integrated blood glucose meter and insulin pen, (2) a mobile application for verified diabetes information from licensed medical personnel, (3) a smart lunch system for safe out-of-home meals, and (4) an improved design of health check-up report format for patients with low health literacy.

South Korean culture, diabetes care, socio-cultural factors

1 Introduction

In South Korea, currently 4.8 M people or 13.7% of the population is diagnosed with diabetes mellitus (DM, hereafter), and it is a growing trend (Korean Diabetes Association, 2017). Between 2012-2016, the number of patient visit for DM treatment totals up to 12.17 M; the cost amounts to approximately 8 billion USD (Lee, 2017).

While type 1 diabetes (T1DM) is "an autoimmune disorder in which the body attacks its own insulin-producing pancreatic cells", and "the disease is not something they brought on themselves" (Brody, 2015), type 2 diabetes (T2DM) is attributed to two major causes: the person's lifestyle choices and genetics. Lack of physical activities, excessive calorie intake, and resulting obesity significantly raise chances of getting T2DM.

To prevent T2DM and other endocrine disorders, doctors recommend weight control, sufficient physical activity, and healthy diet ("Simple Steps to Preventing Diabetes", n. d.). Following the guideline, however, has not been easy for South Koreans. Between 1998-2015, the daily energy intake for South Korean men has increased from 2,196 kcal to 2,489 kcal, while physical activity has decreased for both men and women (Yun, Kim & Oh, 2017). At this moment, nationwide efforts are

called for to prevent DM epidemic, in educating individuals on the disease while removing socio-cultural barriers to a healthy lifestyle.

In this paper, the author reports outcomes from a 16-week undergraduate-level healthcare design course with 15 students, led by two instructors, in collaboration with S hospital (a tertiary medical institution located in W city). While design is relevant to diabetes care in many aspects, this class specifically aimed to investigate design problems coming from cultural characteristics and social environment, such as workplace culture, and the needs of patients who are either enrolled or employed, so most vulnerable to the problems.

2 Research activities

Through the research phase (Week 1 through 7) activities, students gained a broad understanding of the disease itself, patients' daily activities, concerns, struggles, and their indigenous interventions to deal with the disease. The activities do not include interviewing S hospital patients, however, because an expert interview (J. Huh, personal communication, March 17, 2017) revealed that the majority of incoming patients are elderly over 65 from rural areas, while the class aims to develop products/services for younger patients. Though prevalence rate (30.4%), awareness rates (85.2%) are higher among the elderly patients (Diabetes Fact Sheet in Korea 2016, 2017), due to their multimorbidity and inactive lifestyles, elderly patients' diabetes care is trickier, and their attitudes towards treatment options are rather passive-conservative compared to younger patients. Patients between 50-64, in contrast, shows the strongest odds ratio of treatment adherence (Park, 2014, p.85), and they have a broader range of needs in diverse social contexts.

Review of research literature in endocrinology (Appendix A) Instructors provided scientific research articles and documentary films as part of required reading for class discussion. Additionally, students collected 98 news articles written between 2014-2017 on diabetes for assignments. Before meeting with medical experts and patients, the references equipped students with a basic understanding of DM, in the areas of:

- Pathology of DM: how insulin and glucagon control BG levels, causes and symptoms of DM, diagnostic criteria, dangers of hyper- and hypoglycemic states, and possible complications
- Treatment options (e.g., gastric bypass surgery)
- Care activities: medication, insulin/glucagon injection, diet, and physical activities
- Social perception of the disease in South Korean culture and how patients act in response

Expert interviews Students attended activities with medical experts from S hospital in:

- Two introductory lectures on DM, with two endocrinologists and a general physician in the department of preventive medicine: types, causes, diagnosis, and treatment options of DM were explained, and students' collective interview followed where the doctors resolved students' questions and misconceptions.
- A dietetic education session: a nutritionist lectured on DM patients' dietary requirements, optimal calorie intake calculation, food groups and exchange list, glycemic index of food items, and cases of detrimental patient behaviour (e.g., trying unfounded folk medicine).
- A physical activity education session: Students visited W city public exercise and rehabilitation facility to partake in a first-hand experience of body composition analysis, BG monitoring, muscular strength, endurance and flexibility test, and a brief lesson of exercise guidelines for DM patients.
- A lecture on diabetes care product development: a researcher from a BG meter manufacturer gave a talk on current global and Korean market landscapes of diabetes medications and BG meters, available technological options, and his experiences with the DM patients as customers.

Observation of ambulatory care sessions Both instructors and students participated as observers in ambulatory care activities to learn about communication tactics between doctors and patients with lifestyle diseases. The class followed a physician and nurse team to four business sites in W city. Per each site, 10 to 20 workers attended meetings: they were either diagnosed with endocrine disorder or at high risk of developing it, from workplace preventive health screening. Following observation protocol (Appendix B), students made observations on:

- How the doctor explains scientific concepts (e.g., hyperlipidemia, low-density lipoprotein)
- What questions patients ask
- What unhealthy habits they developed at work and why they cannot change them
- How they respond to bad news of having health problems.

Online DM community posting collection Postings from three online communities are analysed to obtain a better understanding of DM patients' daily concerns and behaviours. While limited number of not unlike observations are possible at S hospital—the majority of patients are elderly T2DM from rural areas—the community postings are valuable data from all types of (T1DM, T2DM, and gestational DM) patients living in diverse circumstances.

- *Dangsamo* (http://cafe.naver.com/dangsamo/): *Dangsamo* is an acronym of "diabetes patients' association" in Korean. This community has 20,091 active members and 435,742 postings in total. Among their several discussion boards, approximately 450 recent postings from *All topics* and *Diaries* boards are collected for analysis.
- *Diaries of diabetes patients* (http://danapump.tistory.com): A blood glucose monitor brand *Danapump* hosts this discussion board where 23 postings are available.
- *Friends with diabetes* (http://www.iddm.kr/): An association of T1DM patients. Out of 9,703 postings, 100 recent ones are collected for analysis.

Data analysis methods Students in this class are (with a few exceptions) design majors in their junior and senior years experienced in qualitative data analysis. Part of the lecture was a review of analysis methods student teams can apply, considering types of their data and design solutions:

- Ishigawa (fishbone) diagram (https://goo.gl/XoBeqH) for problem framing: causes of DM, and patients' difficulties caused by DM are analysed with it.
- Flowchart (https://goo.gl/roYtV1) for understanding current diabetes diagnosis criteria and treatment guidelines. Students also utilized flowcharts to build interaction logics for their products (smartphone apps, e.g.).
- Positioning map (https://goo.gl/W258fT) for competition analysis: current products/services were reviewed in comparison, to spot new market opportunities.
- Spradley's universal semantic relationships (1980, as cited in Whitehead, 2005) for encoding themes from lecture, interview, and observation data.
- Fogg behaviour change model (Fogg, 2009) to evaluate patients' current motivation, ability and trigger for behaviour changes as part of design requirement analysis.
- Persona writing (https://goo.gl/8PuZam) for description of target audience and use context in students' product/service proposals.

Analysis revealed that, among research activities, endocrinology literature review and medical doctors' lectures are broadly relevant to all emergent themes, whereas ambulatory care observation, dietetic education session, BG meter manufacturer lecture, and DM community postings are specifically connected to some of the themes (Figure 1). Themes emerged at the end of data analysis were triangulated with another round of literature review.

3 Findings: Socio-Cultural Factors specific to South Korean Culture

In this section, the author will discuss themes that emerged from collected data in three sections. First, doctors' recommendations for diabetes prevention are rather clear, "stay lean and move a lot".

Some aspects of South Korean workplace culture, however, are strong barrier to a healthy lifestyle. Second, after DM onset, patients experience a double whammy of hardships: hiding the disease to maintain social relationships, while staying away from unhealthy diet and drinking at social gatherings. Thirdly, findings from patients' online community postings show they frequently rely on unverified, non-expert, peer opinions for making daily food and medical choices, because professional medical personnel are not always accessible to help.

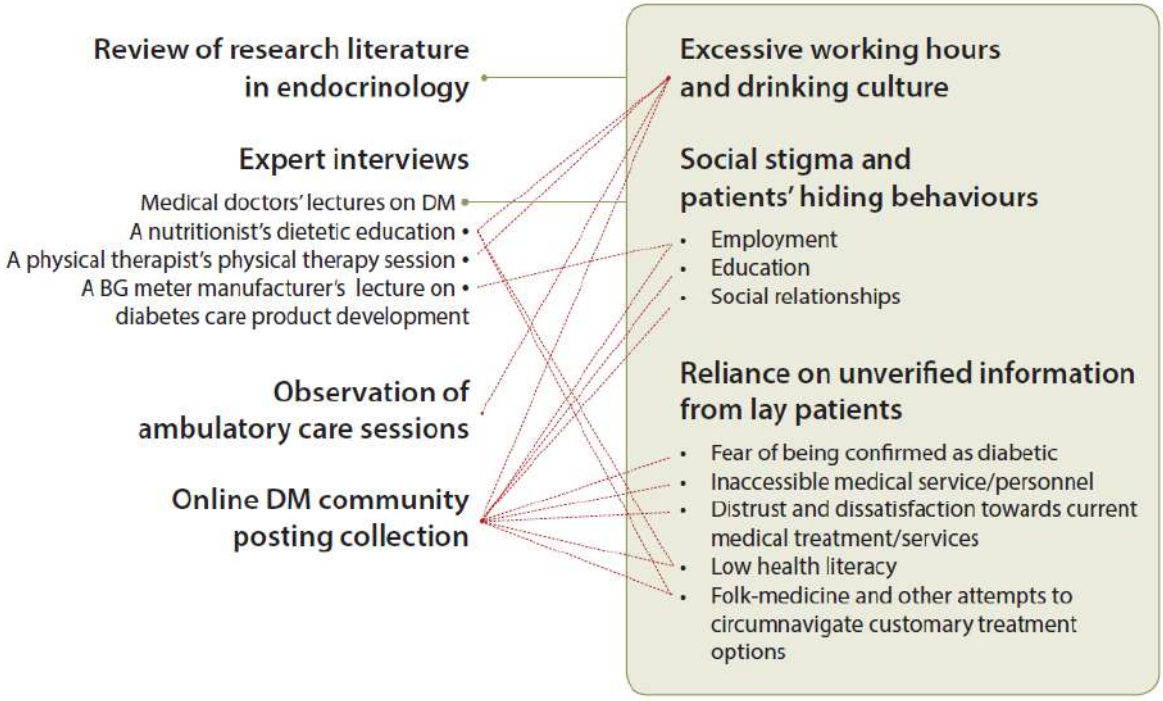

Figure 1 Research activities and findings.

3.1 Excessive working hours and drinking culture

Observations made during ambulatory care sessions exemplify how South Koreans can develop lifestyle diseases, such as DM and/or hyperlipidemia, at work. Emergent themes include:

- Stress from work is frequently mentioned and it causes detrimental habits of having excessive amount of sugary coffee, or drinking/smoking to relieve stress.
- Patients' insufficient health literacy prevents them seeing the gravity of their blood test results. The physician spent some time to interpret the readings for them using various metaphors ("blood vessels and blood are like highways and cars") and vascular age calculation, which surprised and motivated some patients. The physician also recommended keeping blood lab results on their smartphones as constant reminders.
- Drinking is part of work. A person (who has been working in Sales Department for 25 years) mentioned having different drinking occasions five days a week. As he did not know how much alcohol intake is allowed per day, the physician explained it for him with warning about cirrhosis.
- Some patients, however, were still in denial after the consultation, and were busy finding excuses for smoking and drinking ("Isn't it ok if I take cirrhosis meds while drinking?", "I hear nicotine patch is worse than smoking, as nicotine will stay in blood", "Well, I can always sober up in the morning… so…").

Themes repeatedly emerged here were corroborated with research literature. A recent news article ("After 15 years of hard work, what he got is obesity", 2017) reports how long working hours and irregular work schedules cause sleep deprivation, lack of exercise, and late night snacking/drinking

among Korean workers. Jung (2011)'s study concludes that drinking, workload, and stress are correlated to the patients' excessive calorie intake, reduced physical activities, and lower sleep hours.

In fact, one important part of South Korean work culture is attending social gatherings: *hoesik* (회식, literally "eating together"). The problem is, firstly, popular *hoesik* menus (e.g., grilled pork belly BBQ with drinking) are high in calories and fat, thus it can derail patients from their dietary goals. Secondly, a typical *hoesik* entails heavy drinking (more than 50~60g of alcohol intake) that is also correlated to increased blood pressure, triglyceride, abdominal fat and weight gain (Sung, Kim & Reaven, 2007, as cited in Jung 2011) that develop into liver problem, high LDL cholesterol and high blood glucose levels. Thirdly, *hoesik* is typically scheduled after working hours, and it continues until very late hours. There is a positive correlation between sleep shortage and abdominal obesity. As a result, frequent attendance to *hoesik* is a threatening factor to the health of Korean workers (especially for men) in general, and detrimental to employed DM patients.

3.2 Social stigma and patients' hiding behaviours

Patients, however, cannot openly share their health conditions at work and excuse themselves from drinking, because they are too afraid of losing employment status. "The patients I met looked calm and dethatched" said a BG meter manufacturer (H. Park, 2017, personal communication, April 17, 2017), "… and they are afraid of being exposed to have DM. They know employers do not want to hire the diabetics. Whatever happens to patients at work can be attributed to workplace hazard." Regardless of intention, discriminatory acts against DM patients are reported in the following areas.

3.2.1 Employment

In South Korea, where the practice of recruitment health screening is still prevalent despite its unconstitutionality, DM patients are concerned about losing job opportunities. "Korean diabetes patients show a strong tendency to hide their conditions due to fear of being stigmatized at work and in other social relationships", commented a doctor (Park, 2008, translated from Korean text).

The recruitment health screening process is officially abolished in 2005 for private sector with a few exceptions. In reality, however, most employers require it as the last stage of hiring process (Kim, 2016; Son, 2017). A typical physical examination includes blood test for basic metabolic panel, urine test, head, eye, ear, nose and throat exam (HEENT), motor system examination, spirometry, and electrocardiogram test. While the government recommends the screening as a means of matching employees' skillsets with suitable positions AFTER hiring them (G. Park, 2015), some applicants are filtered out due to their health conditions:

> *A former HR department employee at a pharmaceutical company revealed that "Applicants with hepatitis, diabetes, and hypertension are filtered out in the hiring process on hiring managers' decisions […] and we inform them they are rejected because their skillsets are not matching up to what we are looking for." (K. Kim, 2016, translated from Korean text)*

> *I applied to a position at a private university [. …] During the last job interview, the university board chair who happened to be an MD asked "How much do you weigh?", and I was perplexed but answered, "87kg" which is in fact 10kg lighter than what I really weigh. The chair told me to my face, "With that weight in 20s', you will certainly have hypertension and diabetes in 40s, you cannot work here…". I was very upset, but I just replied, "I will try to lose weight…" I felt very humiliated. (Moon, 2014, translated from Korean text)*

3.2.2 Education

For the same reason, school-aged patients can be denied of educational opportunities.

> *Jung-sang, a 6-year old with T1DM, needs insulin shots while attending kindergarten. His parents waited for one year to send him to a private kindergarten where nurses are available, but the kindergarten refused to accept him. "They did not want to be bothered with insulin shots. They said my son can still come, but only at his own risk", his mother said. (Chun, 2016, translated from Korean text)*

The schools, however, believe that they are acting in the patient's best interest. Only 49.2% of school nurses are willing to help patients with injection, because they do not feel confident about glucagon injection, hypoglycemia care, and types/onset/peak hours of insulin. They feel confused about where their responsibilities end in students' diabetes care (Kang, 2015).

Growing up with DM and associated stigma, school-aged patients show hiding behaviours. Choi (2000)'s qualitative study reports how juvenile patients struggle to avoid being marginalized as the sick and weak: "When my classmates try to marginalize me during competitive sports, saying 'you need to rest because you are not well', it hurts my feeling much." (Choi, 2000, p.43, translated from Korean text). Ironically, patients' hiding behaviours diminish their socializing opportunities; they give up participating activities midway, when they cannot secure time and places for medication in private, or when their friends offer alcoholic drinks and cigarettes (Choi, 2000, p.46). Hiding behaviours can also put patients at bigger risks of having hypoglycemia or diabetic ketoacidosis when no one around them knows how to help.

3.2.3 Social relationships

Patients and their family members also struggle to maintain social relationships at schools, work, and home. Marrying DM patients is considered reckless, even to people who currently live with DM patients. On an online community, a woman shared an issue with a diabetic boyfriend. Out of 37 replies, 32 show strong objection to this marriage.

> ***Posting:*** *I recently found my boyfriend is diabetic, and I know it may lower his sex drive … but recently I suspect he avoids having sex with me with many excuses. […] Now I am worried that I might have a sexless marriage. Should I reconsider it? I want to hear what you guys think.*
>
> ***Reply:*** *Sexless relationship is less of a concern. You should google 'diabetes complications' right away. […] Your life will be hell once it begins on your boyfriend. My mother-in-law has been suffering from DM for 30 years, now she has hypertension, diabetic retinopathy operation (and she got weak vision), and needs to be hospitalized with hypoglycemia shock a few times a year. […] now I am fearing my husband will get it too. ("My boyfriend is diabetic...", 2016)*

T1DM patients' insulin/glucagon injection at public places can be absurdly mistaken as drug injection:

> *In an interview, Seungbae, a T1DM patient said, "I need to inject insulin four times a day, and when people see me doing so, they ask if I am doing drugs, or refuse to hire me. […] So I began to hide in restroom stalls for insulin shots. The hectic schedule at work sometimes did not leave me time to go to restroom, however. I missed few shots and health condition got worse." ("Seungbae, type 1 diabetes patient", 2014, translated from Korean text)*

Parents of T1DM patients also have to endure outrageous misunderstanding:

> *Ms. Kim, a mother of a diabetic child said, "People around me wonder why my child needs injection at such a young age. They think I have not been feeding her properly." (Chun, 2016)*

Such misunderstandings lead to hiding behaviours and insulin treatment refusal prevalent among Korean patients. Currently only 11% of the T2DM patients are on insulin treatment, while 77% of

them are on medication (Min, 2017). A recent survey shows that 70% of the respondents are postponing insulin treatment even though they were recommended to start it immediately (C. Kim, 2016). The low adoption rate is rooted in a long-lasting misunderstanding that insulin has an addictive effect, plus fear of needles. Mr. Kwon, a medical doctor, said "I have seen a patient who left for different hospitals when I prescribed him insulin injection. Medication, however, has its own limits." (Min, 2017)

3.3 Reliance on unverified information from lay patients

The dietetic education session with a nutritionist, and an analysis of DM patients' online community postings indicate some patients' reliance on unverified information. Weitzman, Cole, Kaci & Mandl (2011)'s study concludes that the quality/safety of English-spoken DM community sites is variable: among 10 sites, only 50% shows content aligned with scientific recommendations/clinical practice, 20% has audits and association links, and three show advertisement for unfounded *cure* (p. 292). In fact, on Korean-spoken DM communities as well, patients and their families consult other lay patients on treatment, care, and glucose reading, out of following motivations.

3.3.1 Fear of being confirmed as diabetic

45.7% of DM patients wait longer than a month before visiting hospitals because they are too afraid of being confirmed as diabetic (Oh, Park, Shim, and Lee, 2006); perceived seriousness of the symptom, and barriers to doctor visit (e.g., difficulty of making appointment) are deciding factors in prompting treatment-seeking behaviours. The patients are cognizant of their problems, however, and monitor BG levels regularly. They also post BG readings on community sites for opinions. In reply, other community members encourage immediate hospital visits for accurate diagnosis.

> ***Posting:*** *[…] my recent morning fasting BG reading is between 129~131, after meal reading is 149. […] I want to see doctors for accurate diagnosis, but, in addition to my busy schedule, I am too afraid to know I am diabetic, […]. Should I really go to the hospital? Or can I wait for months to see if it gets worse? Please recommend good hospitals for me. […]*
>
> ***Reply:*** *Surely your fasting BG level is high. Stop night snacking and wait for 2 weeks. If you don't see any improvement, I suggest you go and see a doctor. I would say you should go immediately, but I feel for you, you don't like to hear the bad news.*
>
> ***Reply:*** *I suggest you go immediately, I also hesitated and ruined my liver as well. Your fasting BG level is certainly high.*
>
> *("Should I see a doctor?", 2017, translated from Korean text)*

3.3.2 Inaccessible medical service/personnel

DM patients have myriads of questions on daily choices of food and other care activities. Instead of consulting a doctor, they post the questions online to learn from other patients' knowledge. Majority of questions are on food choices—what is safe to eat—which implies limitations of current nutrition education with standardized materials. Lim et al. (2009)'s study concludes that "individualized nutrition education was effective in adherence to diet recommendation and in improving glycemic control and lipid concentrations."

Distrust and dissatisfaction towards current medical treatment/service

Yoo (2015)'s study reports the discrepancy between DM patients and medical personnel on the perceived quality of current medical service. On a 5-point scale, patients' average rating of medical service was much lower (2.95) than self-rated (3.91). On one of the DM communities, patients wrote:

> ***Posting:*** *[…] Normally my after-meal BG level is around 130. Whenever I visit this hospital, BG reading there soars up to 190~230. I asked if their BG meter functioned, and they insisted that the reading was accurate and it was simply high. I am now using*

Perfoma BG meter and its margin of error is just ±5. They could not explain the incongruency between the high BG level and my glycated hemoglobin reading being 5.5. […] Now I stopped trusting this hospital. I went another one and they recommended stopping medication as HbA1c value is just 5.5, while this hospital insists on medication. Should I transfer to another hospital?

Reply: *Why don't you bring your own BG meter and show them the difference? And there is a chance that the doctor is not an endocrinologist. If medication is too strong for your condition, you might suffer from hypoglycemia.*

Reply: *I have been to many hospitals, and trust matters. Experienced doctors at large hospitals are trustworthy. I have experienced misdiagnosis and risked my life several times. […] Try one or two other hospitals specialized in DM treatment.*

Reply: *At primary healthcare institutions, BG reading can be inaccurate, their BG meters and test strips are not maintained as carefully as secondary care facilities. The secondary healthcare facility I went before tests all BG meters for accuracy every morning at 4 a.m. Tertiary care facilities do so. […]*

("I cannot trust this hospital", 2017, translated from Korean text)

3.3.3 Low health literacy

Observations made during ambulatory care visits reveal that some patients did not recognize pathogenesis or severity of endocrine disorders they have, so the physician explained them using various metaphors, while warning them with vascular age calculation. On DM communities, patients share their health check-up reports when they are not sure about medical terms or why the readings are not as optimistic as they expected:

Posting: *My recent workplace health screening report came, and it reads:*

Fasting insulin 1.29 […]

Blood urea nitrogen 19.6 (normal up to 20)
Serum creatinine 0.6 (normal up to 0.9)
Blood urea nitrogen / creatinine ratio 32.67 (normal up to 26)

I do not know what they mean… I was just told that I did not have any problems. Because it was a free health check-up, I have no one to consult.

Reply: *[…] I hear BUN reading varies a lot, after having protein-rich meals or cardio exercise. You should visit the hospital that conducted the check-up and ask. I have also consult my doc last time my BUN/creatinine ratio was too high.*

Reply: *Usually they write something in the MD note section, if you really have problems. If you're still not sure, visit clinics nearby with the report.*

("Let me hear what you think of my check-up results...", 2017, translated from Korean text)

Patients' knowledge in nutrition is not solid either. A nutritionist organizing and conducting dietetic education session mentioned that most patients are elderly, and a few of them are illiterate. Concepts necessary in diet management, such as food exchange list or glycemic index, can be incomprehensible for them. Repeated lessons are recommended, but most patients attend her session just once (E. Shim, personal communication, April 7, 2017).

3.3.4 Folk-medicine and other attempts to circumnavigate customary treatment options

The nutritionist also met patients who tried folk-medicine—e.g., silkworm powder, white mulberry—that are rumoured to lower BG level, but some varieties of it can do more harm than good, such as causing kidney failure. (E. Shim, personal communication, April 7, 2017)

Patients try folk medicine as a quick and easy cure, with or without standard DM treatment. It is problematic in that (1) there is not much systematic pharmacological research available on the usage, dosage, or side effects of the substances, (2) it is sold with unfounded claims—"works better than medications" or "with this, there is no need to restrict your diet"—that patients and their acquaintances believe without vetting the claims, and (3) it interferes with standard DM treatment and sometimes endangers patients' lives—a patient had wild toad and poisoned herself (K. Kim, 1996, pp. 113-117). Another patient tried Nepalese wild honey because it was sold with exaggerated advertising of "impressive therapeutic effect for diabetes"; she suffered from gastritis and colitis for 15 weeks (Shin and Kim, 2016).

On communities, patients exchange their opinions on folk medicine, without expert intervention or guidance. Safety measures of filtering out postings with ungrounded claims are urgently called for.

> ***Posting:*** *I googled 'diabetes' and one site recommends bitter melon. I ordered a box of it. Will it be ok to drink the juice? Here, I haven't met anyone doing so.*
>
> ***Reply:*** *Jerusalem artichokes, bitter melon juice, … they are just teas. Do not rely on them to lower BG levels, they might be better than drinking coffee, though. I have seen a few people who said they have witnessed its effectiveness… diet and physical activities are the best medicine.*
>
> ***Reply:*** *I drink bitter melon tea, too. I like it.*
>
> ***Reply:*** *I just have it as tea whenever I want some teas. It was ok.*
>
> ***Reply:*** *I do not recommend it. Drinking juice can harm your kidney.*
>
> *("Want to know about bitter melon", 2017, translated from Korean text)*

4 Design solution development

With insights gained from the research activities, students developed design concepts during Week 8 through 15 in four teams, to address key design problems they have identified: (1) patients' hiding behaviours to avoid social stigma, (2) relying on unverified information on DM community sites, (3) difficulties of finding safe and balanced out-of-home meal choices, and (4) low health literacy. The researcher from a BG meter manufacturer was invited to the final critique for expert opinions. He commented on feasibility, marketability, and technological aspects to consider for each project. For instance, a team tried to reduce the physical dimension of a BG meter for enhanced portability, but their design was not realistic to hold batteries that meet voltage requirement. Non-invasive glucose monitoring methods—that students preferred, as it resolves patients' discomfort towards blood and needle—are reputed to be not mature enough for mass market, as their margins of error are still higher than that of lancet-and strip methods. From the critique session, students found hints for further developments.

Figure 2 Top-left: A bulky pouch for DM care that many patients carry around. Right: This concept of portable, integrated BG meter and insulin injector intends to assist patients for more discreet DM care in public places and on the move.

4.1 Pocket-sized integrated BG meter and insulin injector device

Design problems:

- Patients show strong dissatisfaction with current lancet-and-strip BG monitoring and insulin injection, due to the discomfort caused by needles or blood (Yoo, 2015).
- BG monitoring and injection are required during outdoor activities (e.g., hiking with others, attending physical education classes), and after every food intake, at various locations and time. Current BG monitoring and injection paraphernalia package (Figure 2, top-left), however, is cumbersome and inconvenient. It does not allow for portability.
- Patients want more discreet DM care experience in public places, as injection at public places can feel embarrassing, and it can be misunderstood as drug use (Seungbae, Type 1 Diabetes patient, 2014).
- CGM (Continuous Glucose Monitoring) and insulin pump devices are available in the market, but the devices are rather costly due to required device change in 3-day interval, and sensors are watertight for up to 30 minutes only; In South Korea, currently health insurance does not cover the cost (S. Shin, 2017).

For DM patients' daytime BG monitoring at work and at schools, one of the student teams developed a design concept of pocket-sized integrated BG meter and insulin injector device (Figure 2, right): the device holds an earlobe clip for non-invasive BG monitoring, a storage space that holds three short insulin pens, and three toggle buttons that push/pull those pens out. Parents can fill the pens with fixed doses of insulin at home, to prevent over- or underdosing accidents. For BG monitoring, patients just pull out the clip and use while hiding the device in the bag. For insulin injection, patients push the needle side of the device against their skin and hit one of the toggle buttons. As most part of the pen is hidden, injection experience is more discreet. While many would argue that hiding behaviours might endanger the patient's life, patients' mental pain of being discriminated and isolated due to the disease also expose them to the risk of economic hardship, psychological morbidity and suicidal attempts (Sarkar & Balhara, 2014). Integrated BG meter and insulin pen is expected to increase frequency of out-of-home BG monitoring and injection, while giving patients more control over their medical safety, privacy, and the range of activities they can participate. The pocket-sized device that is always available can deliver mental relief for patients.

Figure 3 Modang app: (a) Users login as either an medical expert or a lay person. (b) Doctors start by registering their expertise areas. (c) Patients' postings are categorized by topics and assigned to experts. (d) A doctor-patient exchange of comments on hand numbness. (e) For each expert, his/her profile is available on slide-out panel.

4.2 MODANG: a mobile application for verified, reliable diabetes information exchange

Design problems:

- Patients rely on non-expert knowledge and opinions from anonymous online postings for daily decisions (e.g., "What vitamin supplement is good for DM patients?")
- Patients with low health literacy rely on other patients to read their health check-up reports, because hospitals do not provide easy and sufficient explanations for them.
- Patients observe symptoms and phenomena they cannot comprehend (e.g., morning BG level patterns that do not make sense to them); they need someone to provide more plausible explanations on why. Currently, experienced community members—also DM patients—are filling up the role.
- Patients seek for folk medicine as a quick and easy solution to manage BG levels; DM patient communities are a popular place to exchange information on it. Folk-medicine, however, is not safe, because pharmacological research on the usage, dosage, or side effects of the substances are not available.

Second team proposed a concept of mobile application, MODANG, "Diabetes Care for Everyone" in Korean (Figure 3): the app is a collaboration platform for medical experts and patients to access and monitor DM patient community postings, to prevent inaccurate information spreading among them. Medical experts are expected to volunteer on this platform replying questions and encouraging patients to maintain healthy, safe behaviours. Regarding what motivates them to participate, the team argues that (1) physicians from primary care institutions—mostly local, undersized clinics with a capacity of less than 30 beds—would want to contribute, to build solid reputation as an individual doctor and as a medical institution with expertise, and (2) to understand their patients better, because many postings show discrepancies between what patients say during a hospital visit, and what they actually do. Such insights can be developed into new medical solution ideas.

Figure 4 Dang-rak scale, lunchbox and app system. (a) The lunch box is stackable and each container can be measured on the scale. (b) A companion app. (c) Each category of food is weighed for rough calculation of calories. (d) The app shows how much you ate per meal, considering your daily calorie recommendation.

4.3 DANG-RAK: a lunch box for the diabetic

Design problems:

- In Yoo (2015)'s study with 45 participants, patients showed strong dissatisfaction with current diabetes food chart issued from Korean Diabetes Association: the list of food on the chart is limited, and keeping diet diary in reference to the chart is burdensome and difficult.
- Employed patients often struggle with lunch options when they eat at restaurants, because they do not know exactly how many calories are there, or how balanced the meal is nutrition-wise. Preparing lunch themselves is a safe and economic option, if circumstances permit.

Third team developed a concept of stackable lunch box, DANG-RAK ("Enjoy Meals with Diabetes") to assist with patients' out-of-home meals (Figure 4). The product comes with four separate containers for different food groups (grain and other carbohydrate sources, meat, fish, vegetables and fruits) and a scale, to allow for rough but easier estimation of calorie intake and nutritional balance. The lunch box is used with a DM care app where patients regularly record their meals; DANG-RAK scale sends calculated calories from different containers to the app.

4.4 Design renewal of current health check-up report

Design Problems:

- On online communities, patients with low health literacy rely on other patients to read their health check-up results. They do not understand where the problem is or how serious it is. The report is written in medical terms that lay persons cannot understand.
- Current health check-up reports just show readings, without clear directions on what to do about them, or who to contact for further actions.
- Printed health check-up reports are often stored in drawers and the readings are forgotten within a few weeks.
- The report format is text-heavy, while its readability is low with poor typographic treatment.

Another team proposed an improved design and contents of health check-up report (Figure 5). The new format intends to:

- Visualize measurements (e.g., blood pressure chart) and improves readability with better typographic treatment.
- Highlight problem areas in red, where patients need to pay immediate attention.
- Be written in plain language when possible, for patients with low health-literacy.
- Provide clear action items and recommendations for problem areas.

- Allow for detaching the first page summary and recommendations to put it up on the wall, as a constant reminder for his/her health problems.

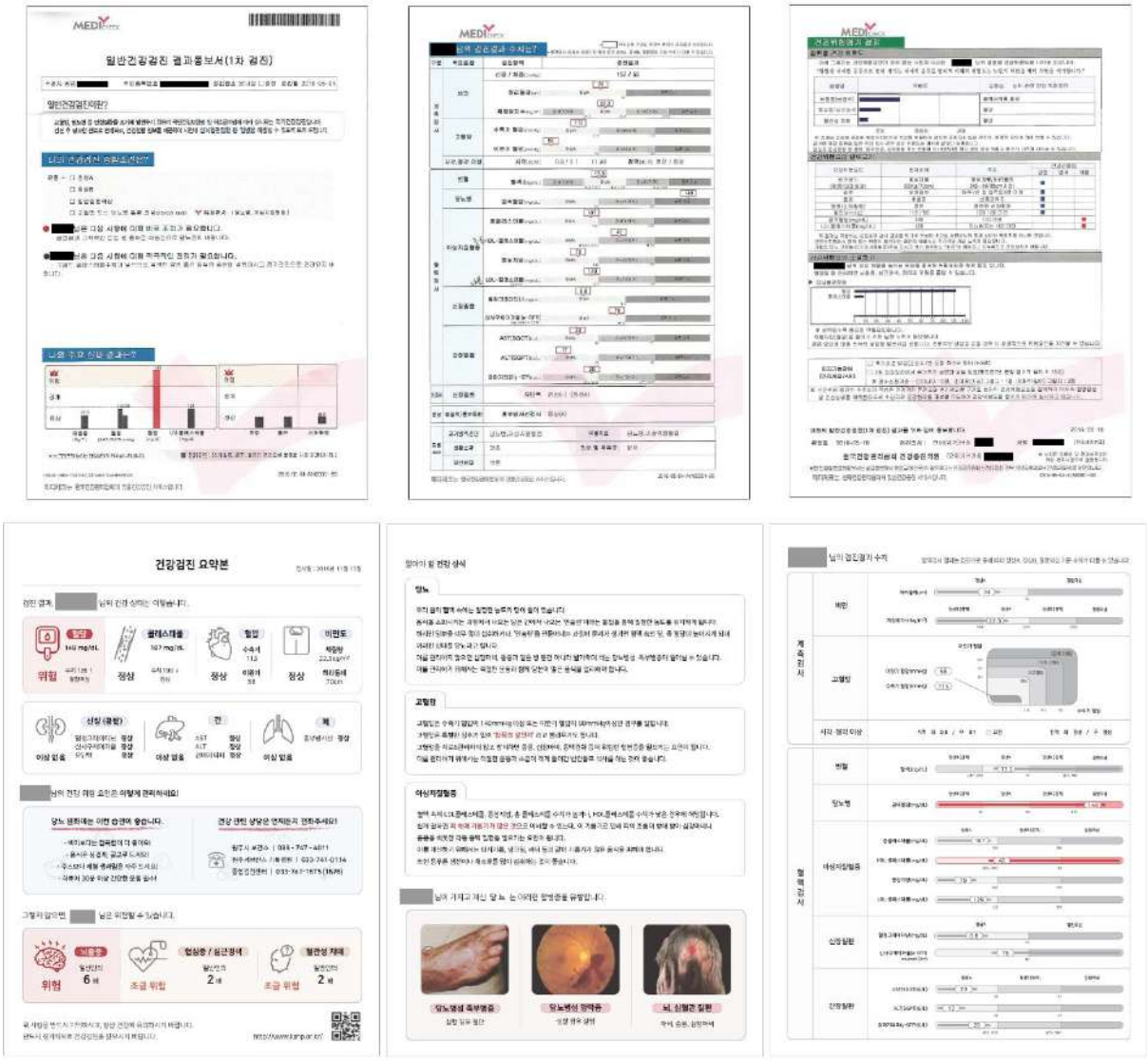

Figure 5 Top-row: Current standard health check-up report format. Bottom-row: Students' proposal of new format, for improved comprehension for lay patients.

5 Discussion

So far, the author reported insights gathered from research activities and how students developed product concepts from them in this 16-week studio class. The most intriguing finding for the author is that the data from different sources tell stories from two perspectives. On one hand, endocrinology literature and expert lectures constitute a discourse around *cure* from medical personnel's point of view. For them, DM patients are people who simply need to comply to treatment to achieve health goals. On the other hand, ambulatory care observation and DM community postings reveal patients' side stories of *living with DM* while maintaining various qualities of social life: patients' pursuit of dignity and security, distrust and dissatisfaction towards current medical services, anxiety and uncertainty they experience daily were vividly painted in their questions and answers. The author wonders if DM care products are being developed and evaluated in terms of how the products better the quality of patient's social life, in addition to their functionalities.

In this section, the author discusses implications of research findings and students' design proposals for the healthcare field, with patients' two psychological dimensions that influence their behaviours and purchase decisions in socio-cultural context: (1) choices between physical or psychological risks, and (2) patients' attitudes, strict or lax, towards treatment.

5.1 Taking physical or psychological risks

Living with diabetes is making daily choices that come with either physical or psychological risks. Patients who are either being educated or employed set implicit boundaries of personal trust: how much and to whom to share their health circumstances. The wider the boundary is, patients have more people to ask for help in case of emergencies, but as the boundary grows the psychological risk of being discriminated or marginalized increases as well. For instance, carrying "I am diabetic" badge can save a patient's life in hypoglycemic emergency situation, it also makes sensitive, private information visible to everyone. Furthermore, for patients who want to be involved in active social interactions, *Saving Face* matters: they are afraid of looking different, or even worse, weak. That fear can prevent them from strictly adhering to treatment/management activities, such as taking a lunch-box to the office every day to avoid having calorie-rich lunch with colleagues. Dang-rak lunchbox (Figure 4) might be a useful solution for balanced diet, but it does not help patients smoothly blend in, unless they are already surrounded by diet-conscious people.

DM care products highly effective in cure but draw unwanted attention can expose patients to other types of risks. Patients' social circumstances, and where patients' priorities are between physical or psychological safety should be considered more in the process of DM care product development, as they can influence patients' purchase decision and product usage. Integrated BG meter and insulin injector device (Figure 2) directly addresses this issue as a more discreet DM care option.

5.2 Patient attitude towards treatment compliance

While most DM care products in the market are designed for ideal patients who faithfully comply to prescribed treatment regimen, real-life patients can be strict or lax. Some patients, for example, use two or more BG meters because reading difference between them can be as high as 44 ("BG readings too different between meters", 2018). Others show rather lax attitude while rationalizing their behaviours that "only God knows when and how a person dies", and they want to talk other patients into deviating behaviours ("Live the way you want", 2016). Patients' weak self-control—along with abovementioned socio-cultural barriers to a healthy lifestyle—can lead to low treatment compliance rate and easy cure (e.g., folk meds) seeking. In managing chronic disease, patients' self-control and emotional processing ability affects juvenile DM patients' health outcomes (Hughes, Berg, & Wiebe, 2012), and the author conjectures the same goes to adult patients.

Products/services for motivating patients, not for motivated patients, are conceivable. One positive function of online DM community is patients encouraging each other to stick to their health goals. Modang, a supervised DM patient community (Figure 3) also aims to provide emotional supports for patients. DM care products with net connectivity, in the same vein, can send notices when a patient stopped using them (meaning s/he stopped medication or injection) for a specified period of time, to ask medical personnel checking up on the patient.

6 Conclusions

In this study, the author reported findings and design outcomes from a 16-week healthcare design course led by two instructors in collaboration with medical experts. Students investigated South Korean socio-cultural factors that adversely affect people's health and trigger diabetes onset: excessive working hours and drinking culture, social stigma and patients' hiding behaviours, and reliance on unverified information from online communities. The same factors also pose serious difficulties in DM patients' diet and exercise management. To address the problems, students proposed four design concepts: (1) a portable, integrated BG meter and insulin pen, (2) a mobile application for verified diabetes information from licensed medical personnel, (3) a smart lunch system for safe out-of-home meals, and (4) an improved design of health check-up report format for

patients with low health literacy. The proposed concepts are meaningful in that two of them directly address psychological dimensions in DM care that have not been considered enough during product development—patients' psychological risks of being exposed to have DM, and lacking strong motivation to comply to treatment. The findings from this study is relevant to other life-style diseases such as hypertension and hyperlipidemia that sometimes accompany T2DM, in that the diseases are also caused from sedentary lifestyle and excessive calorie intake. The proposed concepts need much development in future studies, with a series of user testing and concept refinement.

7 References

"After 15 years of hard work, what he got is obesity." (2017, October 13). *Seoul Shinmun*. Seoul, South Korea. Retrieved from http://www.seoul.co.kr/news/newsView.php?id=20171012005006&wlog_tag3=daum

"BG readings too different between meters." (2018). Retrieved January 10, 2018, from http://cafe.naver.com/dangsamo/583698

Brody, J. (2015, April 20). Mystery and Danger of Type 1 Diabetes. *Nytimes.com*. Retrieved from https://well.blogs.nytimes.com/2015/04/20/mystery-and-danger-of-type-1-diabetes/?action=click&contentCollection=Well&module=RelatedCoverage&region=EndOfArticle&pgtype=article&_r=0

Choi, H. J. (2000). *Disease Experiences of Adolescent Diabetic Patients*. Chung-Ang University.

Chun, J. (2016, October 11). Prejudice against type 1 diabetes patients. *MBC Newsdesk*. Retrieved from http://imnews.imbc.com/replay/2016/nwdesk/article/4136703_19842.html

Diabetes Fact Sheet in Korea 2016. (2017). Retrieved from http://www.diabetes.or.kr/pro/news/admin.php?category=A&code=admin&number=1428&mode=view

Hughes, A. E. M., Berg, C. A. P., & Wiebe, Deborah J. PhD, M. (2012). Emotional Processing and Self-Control in Adolescents with Type 1 Diabetes. *Journal of Pediatric Psychology, 37*(8), 925–934. https://doi.org/http://doi.org.ssl.access.yonsei.ac.kr:8080/10.1093/jpepsy/jss062

"I cannot trust this hospital." (2017). Retrieved October 1, 2017, from http://cafe.naver.com/dangsamo/554171

Jung, J. H. (2011). *Factors related to glycemic control in male workers with Type 2 Diabetes*. Ewha Womans University.

Kang, H. (2015). *School Nurses' Management for Children and Adolescents with Diabetes*. Inha University.

Kanstrup, A. M. (2014). Design concepts for digital diabetes practice: design to explore, share, and camouflage chronic illness. *International Journal of Design*, *8*(3), 49–60.

Kim, C. (2016, March 7). Social predicament with diabetes. *Hankook Ilbo*. Seoul, South Korea. Retrieved from http://www.hankookilbo.com/v/a91e47ac865a4b78b29c9ddad0409e83

Kim, K. (1996). Diabetes and Korean Folk Medicine. In *Proceedings of Korean Diabetes Associations' Annual Educational Conference* (pp. 113–119). Seoul, South Korea.

Kim, K. (2016, May 13). Pre-employment physical exam results are not open to job seekers. Seoul, South Korea. Retrieved from http://www.fnnews.com/news/201605300109478363

Lee, H. (2017, October 18). The number of Korean diabetes patients totals up to 12.17 M. *MedicalToday*. Retrieved from http://www.mdtoday.co.kr/mdtoday/index.html?no=297315

"Let me hear what you think of my check-up results..." (2017). Retrieved October 1, 2017, from http://cafe.naver.com/dangsamo/540220

Lim, H., Park, J.-E., Choi, Y.-J., Huh, K.-B., & Kim, W.-Y. (2009). Individualized diabetes nutrition education improves compliance with diet prescription. *Nutrition Research and Practice*, *3*(4), 315–322. https://doi.org/10.4162/nrp.2009.3.4.315

"Live the way you want." (2016). Retrieved October 1, 2017, from http://cafe.naver.com/dangsamo/475074

Min, S. K. (2017, October 2). Diabetes patients inject avoiding public eyes. *MoneyToday*. Seoul, South Korea. Retrieved from http://news.mt.co.kr/mtview.php?no=2017092613321461673

Moon, D. (2014, January 19). Obesity Discrimination in the Recruitment Process. *OhMyNews*. Seoul, South Korea. Retrieved from http://www.ohmynews.com/NWS_Web/View/at_pg.aspx?CNTN_CD=A0001947943&CMPT_CD=P0001

"My boyfriend is diabetic..." (2016). Retrieved October 29, 2017, from http://www.82cook.com/entiz/read.php?num=2165683

Oh, H. S., Park, H. A., Shim, Y. S., & Lee, Y. H. (2006). A Study on Treatment-seeking Behavior of Diabetes Patients from Detecting Symptoms to Visiting a Doctor. *Korean Journal of Health Promotion and Diseases Prevention*, *6*(1), 55–63.

Paek, S. (2017, July 30). A diabetes patient had life-threatening side-effect from Nepalese Mad Honey. *The Kyunghyang Shinmun*. Ulsan, South Korea. Retrieved from http://news.khan.co.kr/kh_news/khan_art_view.html?artid=201707300854001&code=940301

Park, E. (2014). *Lifestyle disease treatment adherence: review and improvement measures.* Seoul, South Korea.

Park, G. (2015). *A survey of employment discrimination, in South Korea and other countries*. Seoul, South Korea. Retrieved from http://file.passon.co.kr/Assess/Mgs/Bbs/Notice/Ufile/11-채용상 차별에 관한 해외사례 및 실태조사.pdf

Sarkar, S., & Balhara, Y. P. S. (2014). Diabetes mellitus and suicide. *Indian Journal of Endocrinology and Metabolism*, *18*(4), 468–74. https://doi.org/10.4103/2230-8210.137487

"Seungbae, Type 1 Diabetes patient." (2014, April 3). Retrieved January 20, 2017, from http://blog.samsunghospital.com/동춘서커스단-청년의-곡예와도-같았던-삶/

Shin, C., & Kim, H. (2016, November 16). Is there any diet for painless weight loss? *MKNews*. Seoul, South Korea. Retrieved from http://news.mk.co.kr/newsRead.php?no=796111&year=2016

Shin, S. (2016, June 13). Pre-Employment Physical Exam Requirements. *Yonhap News*. Retrieved from https://www.youtube.com/watch?v=Vdppm3_ohBY

Shin, S. (2017, September 23). Ministry of Health and Welfare tries to provide more insurance benefits for T1DM. Seoul, South Korea. Retrieved from http://www.newsmp.com/news/articleView.html?idxno=175315

"Should I see a doctor?" (2017). Retrieved October 1, 2017, from http://cafe.naver.com/dangsamo/543080

"Simple Steps to Preventing Diabetes." (n.d.). Retrieved October 28, 2017, from https://www.hsph.harvard.edu/nutritionsource/diabetes-prevention/preventing-diabetes-full-story/

Son, M. (2017). Study on relation between Body Mass Index and Chronic Diseases based on Work Environment -The Sixth Korea National Health and Nutrition Examination Survey 2013'-. *Law Review*, *17*(2), 253–273. Retrieved from http://www.dbpia.co.kr/Journal/ArticleDetail/NODE07187913?TotalCount=0&Seq=1&isIdentifyAuthor=1&Collection=0&isFullText=0&specificParam=0&SearchMethod=0&Page=1&PageSize=20

"Want to know about bitter melon." (2017). Retrieved October 30, 2017, from http://cafe.naver.com/dangsamo/553517

Weitzman, E. R., Cole, E., Kaci, L., & Mandl, K. D. (2011). Social but safe? Quality and safety of diabetes-related online social networks. *Journal of the American Medical Informatics Association*, *18*(3), 292–297. https://doi.org/10.1136/jamia.2010.009712

Yoo, S. (2015). User participatory medical service design elements for endocrine disease management. *Journal of Korea Design Knowledge*, *33*, 209–218.

Yun, S., Kim, H. J., & Oh, K. (2017). Trends in energy intake among Korean adults,1998-2015: Results from the Korea National Health and Nutrition Examination Survey. *Nutrition Research and Practice*, *11*(2), 147–154. https://doi.org/https://doi.org/10.4162/nrp.2017.11.2.147

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Appendix A. References provided as part of course materials

A1. Scientific research articles

Students read the following articles to learn about pathogenesis, treatment, management of DM, complications, factors affecting patient behaviour (e.g., medication compliance) including health literacy, theories of persuasive design for behaviour change, and qualitative data analysis frameworks.

Choi, C. (2009). Pathogenesis of insulin resistance. *The Korean Journal of Medicine*, *77*(2), 171–172.

Fogg, B. J. (2009). A Behavior Model for Persuasive Design. In *Proceedings of the 4th International Conference on Persuasive Technology*.

Han, S. J. (2011). Exercise in the Elderly with Diabetes. *The Journal of Korean Diabetes*, 12, 37–40.

Hong, K. (2007). A case study of diabetic patients' medication consultation. *J. Kor. Soc. Health-Syst. Pharm.*, *24*(3), 188–195.

Jekal, Y., Lee, M. K., Kim, E. S., Park, J. H., Lee, H. J., Han, S. J., … Jeon, J. Y. (2008). Effects of Walking and Physical Activity on Glucose Regulation among Type 2 Diabetics. *KOREAN DIABETES J*, 32, 60–67.

Kim, C. (2011). Nutritional management for patients with diabetes. *Hanyang Medical Reviews*, *31*(4), 220–227.

Kim, J. (2011). Measuring the level of health literacy and influence factors: Targeting the visitors of a university hospitals outpatient clinic. *Journal of Korean Clinical Nursing Research*, *17*(1), 27–34.

Kim, S. (2011). Medication Adherence of Elderly with Hypertension and / or Diabetes-mellitus and its Influencing Factors. *Kor. J. Clin. Pharm.*, *21*(2), 81–89.

Korean Diabetes Association: Diabetes Diet. (n.d.). Retrieved March 1, 2017, from http://www.diabetes.or.kr/general/food/index.php

Lee, H. (2014). Pancreatic Function for the Digestion of Nutrients. *The Korean Journal of Pancreas and Biliary Tract*, *19*, 39–45.

Lee, I. (2004). Pathogenesis of T2DM: Insulin resistance and decreased insulin secretion. *Annals of Pediatric Endocrinology & Metabolism*, *9*(1), 1–4.

Noh, M. (2014). Quality of Carbohydrate and Diabetes Mellitus. *The Journal of Korean Diabetes*, *15*(2), 104–109. Retrieved from https://synapse.koreamed.org/DOIx.php?id=10.4093/jkd.2014.15.2.104

Seo, J. Y., Bae, S. H., Woo, Y. J., & Kim, C. J. (2010). The Precipitating Factor and Clinical Features of Diabetic Ketoacidosis. *Chonnam Medical Journal*, *46*(2), 94–98. https://doi.org/10.4068/cmj.2010.46.2.94

Song, S., Choi, H., Lee, S., Park, J., Kim, B. R., Paik, H.-Y., & Song, Y. (2012). Establishing a Table of Glycemic Index Values for Common Korean Foods and an Evaluation of the Dietary Glycemic Index among the Korean Adult Population. *Korean Journal of Nutrition*, *45*(1), 80. https://doi.org/10.4163/kjn.2012.45.1.80

Weiss, B. D., Mays, M. Z., Martz, W., Castro, K. M., DeWalt, D. E., Pignone, M. P., … Hale, F. (2005). Quick assessment of literacy in primary care: The Newest Vital Sign. Annals of Family Medicine, 3, 514–522. https://doi.org/10.1370/afm.405.College

Whitehead, T. L. (2005). *Basic classical ethnographic research methods. Ethnographically Informed Community and Cultural Assessment Research Systems (Eiccars) Working Paper Series.* https://doi.org/301-405-1419

Yang, S. J., & Choi, K. M. (2011). Effect of Exercise on Cardiovascular Disease in Patients with Diabetes Mellitus (Aerobic vs. Resistance). *The Journal of Korean Diabetes*, 12, 25–28.

A2. Documentary films:

Episodes from Korean TV documentary series Best Doctors (EBS) and Secret of Life (KBS) were chosen, as the films vividly illustrate how T2DM is developed, prognosis of DM, and dangers of DM complications in detail, along with patient and doctor interviews. Part of the films discuss periodontitis and arthritis: the diseases are common to old-aged DM patients, and they both aggravate, and are aggravated by, diabetic conditions.

Choi, T., Lee, N., Lee, S., Moon, H., Yun, C., Lee, C., … Kim, J. (2016). *Secret of Life (TV series) Ep. 604: Diabetes Complications.* Korea, Republic of: KBS (Korean Broadcasting System). Retrieved from http://www.kbs.co.kr/1tv/sisa/health/view/vod/index.html?kwd=604

Hwang, H. (2014). *Secret of Life (TV series) Ep. 518: You're going blind - three diseases that affecting your vision.* Korea, Republic of: KBS (Korean Broadcasting System). Retrieved from http://www.kbs.co.kr/1tv/sisa/health/view/vod/2334909_91757.html

Hwang, S., Park, J., Ryu, G., Chang, G., Lee, J., & Yun, S. (2015). *Best Doctors (TV series) Ep. 392: Periodontal (gum) disease, Life threatening disease.* Korea, Republic of: EBS (Educational Broadcasting System). Retrieved from http://www.ebs.co.kr/tv/show?prodId=454&lectId=10283993

Hwang, S., Park, J., Ryu, G., Chang, G., Lee, J., & Yun, S. (2015). *Best Doctors (TV series) Ep. 393: Diabetes, Life threatening disease.* Korea, Republic of: EBS (Educational Broadcasting System). Retrieved from http://www.ebs.co.kr/tv/show?prodId=454&lectId=10286093

Lee, Y., Hwang, S., Chang, K., Yoon, S., Choi, S., & Chung, J. (2016). *SBS Special Ep.430: Are you still having sugar?* Korea, Republic of: SBS (Seoul Broadcasting System). Retrieved from http://allvod.sbs.co.kr/allvod/vodEndPage.do?srs_id=22000065217

A3. 98 Newspaper articles student searched with keyword 'Diabetes'. Due to the limited space, the author listed a few of them here as examples:

Cho, D. (2015, May 5). Having to hide insulin injections, ... "Care is a cure" for school-aged diabetics. *SBS News8*. Seoul, South Korea. Retrieved from https://news.sbs.co.kr/news/endPage.do?news_id=N1002961648

Cho, D. (2015, July 7). Diabetic complications: Chronic renal failure. The Korea Times. Seoul, South Korea. Retrieved from http://www.koreatimes.com/article/20150707/928410

Choi, E. (2016, April 5). 2.52 million diabetes patients are treated per year ... medical expenses exceeded 1.8 trillion Korean won. *Dailypharm.com*. Seoul, South Korea. Retrieved from http://www.dailypharm.com/News/210327

Corbin, L. (2016, December 6). DietSensor laser, app help those with diabetes count carbs. *ABC.com*. GLENDALE, Calif. Retrieved from http://abc7.com/health/dietsensor-laser-app-help-those-with-diabetes-count-carbs/1668790/

"For sweet potatoes, calorie changes depending on cooking methods: grilling or steaming." (2015, April 28). *DongA.com*. Seoul, South Korea. Retrieved from http://news.donga.com/3/07/20150428/70960172/2#csidxf5291efcad3f5be935b8766356b60c1

"GlucoTrack", a blood-free blood glucose meter for diabetics. (2017, January 18). *Seoul Shinmun*. Seoul, South Korea. Retrieved from http://www.seoul.co.kr/news/newsView.php?id=20170118500051

"[Health Talk] Causes of Elderly Death." (2014, October 28). *Junsungki.com*. Retrieved from https://www.junsungki.com/goheyday/article/details.page?&name=article_255&magazineSeq=255

"Join Medical launches GlucoTrack, BG meter without finger prick, in Korea." (2017, January 18). *Hankyung.com*. Seoul, South Korea. Retrieved from http://news.hankyung.com/article/201701182546a

Joo, A. (2017, February 14). Up to 20% premium discount if you quit smoking. *DongA.com*. Seoul, South Korea. Retrieved from http://news.donga.com/BestClickIlbo/3/all/20170214/82851372/1#csidx3a6b46ebc81b4afbadf82a53ff6f784

Kim, H. (2009, July 7). "Lean diabetes" specific to Koreans surge. *DongA.com*. Retrieved from http://weekly.donga.com/List/3/all/11/87902/1

Kim, J. (2017, April 4). School-aged diabetes patients are left to themselves to give their own insulin injections in toilets. *Segye Ilbo*. Seoul, South Korea.

Kim, S. (2013, November 1). Types and cost of cataract surgery. *Kyunghyang Shinmun*. Seoul, South Korea. Retrieved from http://news.khan.co.kr/kh_news/khan_art_view.html?artid=201311011517132&code=900303

Koo, H. (2017, March 2). The last 10 years to live in pain ... Expense of older age medical expenses. Seoul, South Korea. Retrieved from http://news.jtbc.joins.com/article/article.aspx?news_id=NB11431675&pDate=20170302

Lee, B. (2016, March 29). Old diabetic patients take six medicines a day ... Drug Interactions should be considered when you prescribe for them. *Chosun.com*. Seoul, South Korea. Retrieved from http://health.chosun.com/site/data/html_dir/2016/03/28/2016032802624.html

Lee, G. (2012, May 30). GI is high in peaches, low in sweeter apples. *Chosun.com*. Seoul, South Korea. Retrieved from http://health.chosun.com/site/data/html_dir/2012/05/30/2012053000039.html

Lee, J. (2006, November 14). Diabetes symptoms in the mouth. *Kyunghyang Shinmun*. Seoul, South Korea. Retrieved from http://news.khan.co.kr/kh_health/khan_art_view.html?artid=200611140918181&code=all

Lee, J. (2017, April 13). Apple is rumored to be developing needle-free BG measurement technology. *ZDnet*. Seoul, South Korea. Retrieved from http://www.zdnet.co.kr/news/news_view.asp?artice_id=20170413113519&type=det&re=

Lee, K. (2016, November 28). Causes of arteriosclerosis in Korean diabetic patients: small, dense, low-density lipoprotein(sdLDL). *Chosun.com*. Seoul, South Korea. Retrieved from http://health.chosun.com/site/data/html_dir/2016/11/28/2016112800956.html

Park, H. (2010, December 9). [Health]Unfortunate combination of diabetes and obesity. *Kyunghyang Shinmun*. Seoul, South Korea. Retrieved from http://news.khan.co.kr/kh_news/khan_art_view.html?artid=201012092119065&code=900303

Park, J. (2016, July 25). Gastroenterology shows excellent therapeutic effect to "lean diabetes" specific to Koreans. *Chosun.com*. Seoul, South Korea. Retrieved from http://news.chosun.com/site/data/html_dir/2016/07/24/2016072400667.html

Ryu, J. (2017, April 10). Korean Diabetes Association Announces Award Winners for Insulin Therapy Testimonials Contest. *ACROFAN*. Seoul, South Korea. Retrieved from http://kr.acrofan.com/detail.php?number=40729&type=&lang=&UA=

Sohn, J. (2017, January 30). Excessive working hours in South Korea continue unabated. *Chosun.com*. Seoul, South Korea. Retrieved from http://news.chosun.com/site/data/html_dir/2017/01/31/2017013100209.html

Sohn, Y. (2016, August 1). Dr. Kitchen, a dietary service company for diabetic patients, attracts KRW 1.4 billion worth of investment. *Platum.kr*. Seoul, South Korea. Retrieved from http://platum.kr/archives/64047

Song, B. (2004, January 6). 2. Diabetes and cerebrovascular disease. *Medical Observer*. Seoul, South Korea. Retrieved from http://www.monews.co.kr/news/articlePrint.html?idxno=13171

Song, S. (2013, February 18). [Medicine] Increase in childhood diabetes. *Joongboo Ilbo*. Incheon, South Korea. Retrieved from http://www.joongboo.com/news/articleView.html?idxno=838356

"Three principles of diet for the diabetics." (2017, April 4). *Chosun.com*. Seoul, South Korea. Retrieved from http://news.chosun.com/site/data/html_dir/2016/05/04/2016050400749.htm

"Why do people with diabetes do not check blood glucose?!" (2011, September 6). *Chosun.com*. Seoul, South Korea. Retrieved from http://health.chosun.com/site/data/html_dir/2011/09/05/2011090501737.html

Wortham, J. (2016, March 23). We're More Honest with Our Phones Than with Our Doctors. *Nytimes.com*. Retrieved from https://www.nytimes.com/2016/03/27/magazine/were-more-honest-with-our-phones-than-withour-%0Adoctors.html

Yang, Y. (2016, May 9). Childhood diabetes incidents increased 31% in 10 years. *Medical Observer*. Seoul, South Korea. Retrieved from http://www.monews.co.kr/news/articleView.html?idxno=91272

Zolfagharifard, E. (2015, June 4). Count calories using PHOTOS: Google's Im2Calories app will reveal nutritional value of meals from your Instagram snaps. *Mail Online*. Retrieved from http://www.dailymail.co.uk/sciencetech/article-3109726/Count-calories-using-PHOTOS-Google-s-Im2Calories-app-reveal-nutritional-value-Instagram-snaps.html

Appendix B. Field Observation Protocol

- Arrive at designated location on time.
- Wear name tags.
- Students are allowed to take notes.
- Do not use smartphones at all for anything, turn off the phone during observation.
- Comply to medical personnel's direction in his/her office.
- Write down all your questions and ask them when the doctor's shift is over.