Academia–industry digital health collaborations: A cross-cultural analysis of barriers and facilitators

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Abstract

Background: Development and uptake of digital health technologies benefit from cross-sectoral efforts from academia and industry. Our study aims to identify the barriers and facilitators associated with academia–industry collaborations in digital health in middle- and high-income countries.

Methods: Trained personnel conducted semi-structured interviews with 23 stakeholders who were active in industry, academia or both. Stakeholders were based in middle-income countries (including China) and high-income countries (including the United States) as defined by the World Bank. Interviews were conducted in the stakeholder's language of choice (Chinese, $n = 12$; English, $n = 11$). Qualitative interview questions elicited perspectives on stakeholders' experience with academia–industry collaboration, challenges faced, and factors that facilitated the process. Interviews were audiotaped, transcribed verbatim, thematically coded by bilingual coders and analyzed using inductive content analysis.

Results: Stakeholders in both academia and industry identified complementary roles, authentic communication between partners, and clearly outlined goals or expectations prior to the collaboration as primary facilitators for success. Misaligned goals or expectations, differences in timelines for productivity and difficulties balancing expectations for business outcomes versus generation of scientific evidence were identified as primary barriers. Stakeholders in high-income countries reported inauthentic communication as a significant barrier to collaboration, whereas those in middle-income countries did not.

Conclusion: Outlining and communicating openly about goals and expectations for timeline and priorities as well as establishing complementary roles will facilitate fruitful academia–industry collaborations in the future. Best practices for communication styles may be dependent on the cultural setting, and thus should be adopted accordingly.

Keywords

Intersectoral collaboration, knowledge translation, telemedicine, global health, qualitative

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Introduction

Technological advancements can provide opportunities for the global health community to tackle health challenges using novel tools.[1] Digital health including mobile health, wearable devices, telehealth and health information technology has not only changed the way people communicate but also the way we monitor and improve health and wellness. Both the development and implementation of digital health technology can benefit from partnerships across sectors.

Academia–industry collaboration can be particularly beneficial by leveraging unique resources, expertise and networks for testing effectiveness. In the United States, such collaborations have allowed for the development of scalable, usable programs for important public health issues such as diabetes prevention in a multi-lingual, low-income population.[2] These collaborations have also spanned countries for multi-nation implementation and use.[3] However, academia–industry collaborations in digital health are complex and not without challenges, such as competing interests related to scientific rigor and commercial viability.[4,5]

Uncovering challenges mid-collaboration can be obstructive. Yet, guidance on establishing productive academia–industry working relationships to promote digital health is sparse. Hingle and colleagues[6] outlined several actions that academic and industry partners could take to ensure a smooth and successful collaboration. For example, academic partners could be open to selecting several outcomes as indicators of potential viability, while industry partners could aim to align their product with the evidence base. However, this does not provide a comprehensive picture of additional challenges that could arise over the course of developing a working relationship between parties.

In this study, we sought to obtain perspectives on barriers and facilitators to academia–industry partnerships for digital health from individuals active in its development and implementation. Our purpose was to identify similarities and differences across sectors and also across countries, with a focus on engaging stakeholders in both middle- and high-income countries. Findings could serve as a foundation for potential partners across sectors and countries to have better collaborative experiences, to not delay efforts, and to reap larger potential population health benefit.

Methods

Study design and recruitment

This exploratory study was conducted in Kunshan, China during the Duke Kunshan Conference on Digital Health Science and Innovation: Partnership between Academia and Industry, held on 14 October 2017, at Duke Kunshan University, Kunshan, China (www.dukekunshan.edu.cn/en), with additional planning coordination from Duke University (www.duke.edu) and ACCESS Health International China (www.accessh.org/china). We recruited participants from academia and industry through mailing lists for Duke Global Health Institute at Duke University, the Global Health Research Center at Duke Kunshan University, and ACCESS Health International. We also conducted outreach using platforms for Duke Kunshan University and ACCESS Health International on WeChat, the most widely used messaging and social networking application in China.[7]

Stakeholder interviews

Delegates who presented their latest digital health studies or innovations in the conference were asked to share their experience on cross-sectoral collaboration. They came from middle-income countries and high-income countries[8] including the United States, China, and other countries in the Asia-Pacific region (all references to countries in the Asia-Pacific region hereafter do not include China).

Of the 24 stakeholders approached, 23 (95.8%) consented to being interviewed. Semi-structured interviews were conducted according to pre-specified interview guides by trained research personnel. Written informed consent was obtained prior to the interviews. Interviews were conducted in the stakeholder's language of choice (Chinese, $n = 12$; English, $n = 11$).

The following qualitative interview questions elicited discussions about stakeholders' past experiences with academia–industry collaboration, challenges they faced, and factors that facilitated the process: (a) Are you currently part of an academia–industry collaboration? If so, what is involved? (b) What are some of the challenges you have faced as part of this collaboration? and (c) What are some of the facilitating factors that allowed you to have a successful collaboration? All interviews were audiotaped and transcribed verbatim.

Qualitative coding and analysis

Using conventional content analysis, we derived codes during data analysis.[9] The research team had five iterations of the codebook, after which no new codes could be identified to answer the primary research question using information provided in the qualitative interviews. The codebook content with all codes and subcodes is shown in Table 1. We examined the co-occurrence of each theme with the "barrier" and "facilitator" codes to determine how often these themes were discussed as something that challenged or facilitated the collaborations. We used the "Case" function in NVivo to analyze the interviews of stakeholders with industry versus academia affiliations,

Table 1. Codes and subcodes identified from stakeholder interviews for academia–industry collaboration in digital health.

Code	Subcodes
Communication	Different languages of communication (e.g. actual language difference due to nationality, technical language)
	Authentic communication
	Inauthentic communication
	Sustained communication
	Information sharing
Relationships	Complementary roles
	Strong relationship
	Weak relationship
Product	Longevity of technology
	Addresses needs of end-users
	Does not address needs of end-users
	Promotion to end-users (e.g. user buy-in)
	Laws and regulation
	Other
Goals or expectations	Aligned goals or expectations
	Misaligned goals or expectations
	Prioritizing scientific evidence
	Prioritizing business outcomes
	Timeline
	Scaling up
	Proprietorship (e.g. intellectual property)
	Other
Funding	Academia funds industry
	Industry funds academia
	Lack of funding
	Government funding/support
	Other

and then of stakeholders from middle-income versus high-income countries.

Two bilingual coders ((Chelsea Liu) CL, SS) thematically coded the data as depicted in Table 1. We co-coded each theme in this table with either "barrier" or "facilitator", but not both. Using the NVivo software, we tested the agreement between CL and SS by calculating the overall kappa coefficient, a statistical measure of inter-rater reliability. A detailed description of how to calculate the kappa coefficient has been described elsewhere.[10] Overall, coders SS and CL had moderate inter-rater reliability (kappa = 0.56).

Results

Table 2 summarizes demographic and occupational information of the stakeholders. Among the 23 stakeholders interviewed, 11 were from academia and 11 were from industry, and one was actively involved in both. Fifteen were from middle-income countries and eight were from high-income countries. Stakeholders participated in many forms of academia–industry collaborations in digital health. Academic stakeholders work in public and private universities, some of which have affiliated hospitals, and public health foundations. Industry representatives work in companies providing integrated medical services both online and offline, venture capital firms investing in medical e-commerce startups, government-affiliated telecommunication companies, providers of home healthcare for community-dwelling older adults, and technology companies that develop health-related applications such as interactive games and e-health management platforms (Table 3).

Table 2. Demographics of stakeholders who completed interview.

n (%)	Academia (n = 11)	Industry (n = 11)	Both (n = 1)
Female	2 (18.2%)	8 (72.7%)	0 (0%)
Country			
USA	4 (36.4%)	1 (9.1%)	1 (100.0%)
China	4 (36.4%)	10 (90.9%)	0 (0%)
Other[a]	3 (27.3%)	0 (0%)	0 (0%)
Language			
English	9 (81.8%)	1 (9.1%)	1 (100.0%)
Chinese	2 (18.2%)	10 (90.9%)	0 (0%)

[a]Includes stakeholders from middle-income and high-income countries in Asia-Pacific region (excluding China).

Interviewees from both academia and industry reinforced the need for cross-sectoral collaboration in digital health. From the perspective of a stakeholder in industry, the ability to conduct large-scale analytics can be restricted by the lack of meaningful healthcare data, and thus motivates the need for collaboration with academia:

> Currently we have access to a lot of electronic prescription data. However, I do not think the value of these data has been fully utilized. Little insight could be gained from looking at the prescription data alone. If we could link them to other data in the healthcare ecosystem, meaningful analysis could be undertaken. [Stakeholder from industry, China; translated from Chinese]

For an academic, the need to collaborate with industry may stem from the need for scaling up or disseminating a product or service to maximize its impact:

> When it comes to industry, I am of the opinion that digital innovation is best disseminated commercially, including to extremely low-income populations. And that is because digital innovation requires an infrastructure, that is well beyond the resources of most healthcare settings. [Stakeholder from academia, Asia-Pacific region]

Regarding the barriers and facilitators of academia–industry collaborations, six central themes emerged from the discussions: (a) authentic communication between partners; (b) strength of relationship between partners; (c) alignment or misalignment of goals or expectations; (d) individual priorities regarding business outcomes or scientific evidence; (e) timeline of collaboration; and (f) complementary stakeholder roles in the collaboration (Table 3). Each subcode under "product" and "funding" (Table 3) was discussed on fewer than two instances in total, none of which were in conjunction with "barriers" or "facilitators", and therefore we did not include them in the following analysis, focusing on themes that were identified as potential barriers or facilitators to the collaboration.

Authenticity of communication

This code refers to instances where stakeholders identified the importance of open, transparent communication in their collaborations. This was frequently co-coded with facilitators. For example,

> I work a lot in industry and I just say up front you have to be transparent. Anything we do will be registered as a trial and will be published. And once we're finished everybody benefits from this research, but you guys get the technology. [Stakeholder from academia, United States]

This theme is also co-coded with barriers where stakeholders discuss the consequences of inauthentic communication:

> We just need more discussion between academia and industry, because I think what you realized really quickly is when you meet another, [you may] be suspicious of people until you meet them and have conversation with them. Like any other area, you just need to have conversation. I think it is absolutely critical. [Stakeholder with affiliation in academia and industry, United States]

Strength of relationship

Stakeholders also identified the need to build strong relationships in their collaborations, although this was not the focus of most discussions. For example,

> It's trust, you know building trust and confidence in the relationship. And it's mutual respect . . . So then it means

Table 3. Themes most frequently co-coded with "barriers" or "facilitators".

Theme	Frequency of co-coding with barriers	Frequency of co-coding with facilitators
Communication		
Authentic communication	–	17
Lack of authentic communication	10	–
Goals and expectations		
Alignment	–	20
Misalignment	20	–
Conflicting priorities		
Prioritizing business outcomes	21	–
Prioritizing scientific evidence	27	–
Timeline	25	–
Complementary roles in collaboration	–	31
Strong relationship	–	9

when things don't work out, or at a particular moment in time, people have a different view or perspective or have an argument etc. This doesn't ... destroy the relationship because there are very strong foundations there. [Stakeholder from academia, Asia-Pacific region]

Alignment or misalignment of goals or expectations

This theme refers to any form of discord about the goals of the collaboration. As shown in Table 3, stakeholders emphasized the importance of this theme in 40 separate instances, with 20 referring to alignment of goals and the other 20 referring to misalignment. For example,

Whenever we define project, both sides have to be very clear about expectation and outcome for this project. [Stakeholder from academia, United States]

The two sides don't know what the other is doing. I think it's necessary to set up something as soon as possible even if that connection is not great, but you need to apply [this resource] as soon as possible. [Stakeholder from industry, China; translated from Chinese]

While alignment of goals or expectations is co-coded with facilitators, misalignment is co-coded with barriers. The following is an example of misalignment of goals or expectations:

You know our expectations from an academic perspective are on establishing generalizable knowledge and on intending to improve health in this digital health. From an industrial perspective, sometimes theirs is a business case, its financial incentive ... so really having a clear understanding of what those expectations are and how do we meet both. [Stakeholder from academia, United States]

Priorities regarding business outcomes or scientific evidence

This theme refers to conflicting priorities specific to business outcomes or scientific evidence. When speaking of how the importance of scientific evidence can act as a barrier, stakeholders from academia said the following:

Even if you can present evidence that the approach that [industry partners] are recommending doesn't work or there's no evidence, that's often not such a big concern for them. Because they have already decided that this is the best solution for the situation. And often they are not

so interested in what might be the longer term benefits or problems with this approach. [Stakeholder from academia, Asia-Pacific region]

There are things we know to be good science, that ... they aren't going to do because they are too expensive. [Stakeholder from academia, Asia-Pacific region]

In contrast, a stakeholder from industry expressed concern for conflicting priorities from the perspective of businesses feeling pressured to meet a bottom line:

Academia is driven by publishing on target research whereas industry is heavily influenced by financial incentives. Even for large state-owned enterprises, they are under the pressure to achieve a favorable bottom line and paying wages on time. [Stakeholder from industry, China; translated from Chinese]

Timeline of collaboration

This code was assigned to instances where stakeholders discussed the need to have an agreement on the timeline for completing projects.

Interviewees from both academia and industry identified timeline as a barrier to collaboration due to longer time frames in research projects contrasting with greater emphasis on quick implementation in industry. For example,

Before research gets implemented. And that's just the research that gets implemented. Most never gets implemented. So, it's a long pipeline. [Stakeholder from academia, Asia-Pacific region]

The data collected by professors cannot be used by industry quickly whereas industry's way of doing business has never been wholly accepted by academia. [Stakeholder from industry, China; translated from Chinese]

I think the pace for academia is very different for industry that has been some of our biggest challenges. Many of our industry partners want to go and start tomorrow. In academia, we need IRB, we need security approval. Appropriately so ... Those discussions within academia take far longer than they do within industry. [Stakeholder from academia, United States]

Complementary roles

Stakeholders identified the need to have different but complementary roles in collaborative projects. This

theme was most frequently co-coded with facilitators. For example,

> [T]here is a tremendous potential for industries to profit off of successful interventions. So I think they are certainly open to partnering...I think they're certainly interested in looking at ways to improve outcomes, either as a complement to a drug or as a substitute. [Stakeholder from academia, Asia-Pacific region]

> The professor can publish their results and conclusions. The industry can use the conclusions reached by the academic community. [Stakeholder from industry, China; translated from Chinese]

> The industry-academy collaboration is always useful, because academia...it depends on people like us as the academia parts, as health services researchers and you are focusing on developing some kind of resources, or improving service for the health systems. [Stakeholder from academia; Asia-Pacific region]

Comparison between academia and industry interviewees

As shown in Table 4, stakeholders in academia and industry both identified "authentic communication", "aligned goals and expectations" and "complementary roles" as facilitators; both identified "prioritizing business outcomes" and "timeline" as barriers. However, only the academia group identified "prioritizing scientific evidence" as a top barrier, and only the industry group identified "misaligned goals and expectations" as a top barrier.

Comparison by country

Results of comparisons by country are shown in Table 5. Stakeholders who are based in middle-income and high-income countries both identified "prioritizing business outcomes" and "timeline" as barriers to collaboration. Both also identified "aligned goals and expectations" as well as "complementary roles" as facilitators to collaboration. Only the high-income country group identified "authentic communication" as a top facilitator, and only the middle-income country group identified "misaligned goals and expectations" as a top barrier.

Discussion

In this qualitative study of barriers and facilitators in academia–industry collaborations, stakeholders who were primarily from China and the United States identified authentic communication, alignment of goals and expectations, adoption of complementary roles, and having a strong relationship with partners as the primary facilitators for successful collaborations. Stakeholders identified misaligned goals and

Table 4. Top three barriers and facilitators identified by stakeholders affiliated with academia ($n = 12$) versus industry ($n = 12$).

Academia (frequency of co-coding)	Industry (frequency of co-coding)
Facilitators	
Authentic communication (13)	Authentic communication (6)
Aligned goals and expectations (10)	Aligned goals and expectations (10)
Complementary roles (20)	Complementary roles (11)
Barriers	
Prioritizing scientific evidence (13)	Misaligned goals and expectations (14)
Prioritizing business outcomes (12)	Prioritizing business outcomes (11)
Timeline (13)	Timeline (14)

Responses of the stakeholder affiliated with both academia and industry are included in both groups.

Table 5. Top three barriers and facilitators identified by stakeholders based in high-income ($n = 8$) versus middle-income countries ($n = 15$).

High-income country (frequency of co-coding)	Middle-income country (frequency of co-coding)
Facilitators	
Authentic communication (10)	Prioritizing scientific evidence (7)
Aligned goals and expectations (7)	Aligned goals and expectations (13)
Complementary roles (13)	Complementary roles (17)
Barriers	
Prioritizing scientific evidence (9)	Misaligned goals and expectations (15)
Prioritizing business outcomes (8)	Prioritizing business outcomes (13)
Timeline (10)	Timeline (12)

expectations, conflicting scientific or business priorities and conflicting timelines as primary barriers. Overall, stakeholders from both academia and industry agreed that cross-sectoral collaborations are essential for the successful implementation of digital health initiatives.

Academics who work in the field of digital health aim to establish health behavior change and positive health outcomes among end-users.[5] However, existing pathways to translate biomedical research findings into commercial products are not well-suited for digital health projects.[11] Hiring outside consultants to build digital tools is often unsustainable, since projects would often end with the grants that supported them.[11] As such, these goals may be difficult to accomplish at a large scale without commercialization, collaboration and implementation with industry. On the other hand, companies are increasingly aiming for competitive advantage in the marketplace by including scientific evidence in digital health products.[5] They validate their products with rigorous scientific evaluation, which requires collaboration with partners in academia.[5] In response to these needs, leaders in the field of digital health have increasingly called for cross-sectoral collaborations that are mutually beneficial, highlighting the need for partners to take on complementary roles.[5] In addition, a pilot study of academic and industry stakeholders' attitude on technology disruption in behavioral health research found that weaknesses in one party are often complemented by strengths in the other.[12] For instance, academic partners are perceived to be less savvy with technology, an area in which industry partners generally excel. This was reflected in our study's finding that stakeholders from both fields identified having complementary roles as the leading facilitator to collaboration.

The ways in which timeline and misaligned goals or expectations act as barriers to academia–industry collaborations in digital health have been explored in the literature.[5,13] The prevailing paradigms in health sciences heavily rely on randomized controlled trials to establish evidence base of digital health interventions. Technological changes, however, progress quickly and may render these paradigms obsolete by the time that rigorous scientific evidence has been established. Furthermore, some industry partners aim to develop a product that is highly innovative, which could come into conflict with the risk-averse nature of those in the healthcare profession whose priority is patient safety.[13] Our analysis confirmed the existence of the aforementioned barriers and the challenges they pose to effective academia–industry collaborations; academic partners expressed concern that industry counterparts did not pay sufficient attention to scientific rigor of the product, while industry partners believed that academics

over-prioritize publication instead of bringing the product to end-users.

As digital health collaborations increasingly branch out across multiple countries and require collaboration with partners from different backgrounds,[14] challenges may be compounded by the need for effective cross-cultural communication. In this study, stakeholders in high-income countries identified authentic communication as a top facilitator to collaboration, whereas those in middle-income countries did not. Of note, the majority of the stakeholders participating in this study from middle-income countries were from China and the majority of those from high-income countries were from the United States. In a study on differences in communication styles between Americans and East Asians, Sanchez-Burks and colleagues[15] showed that East Asians pay more attention to indirect cues in work settings. This may help explain why authentic communication was not mentioned frequently in interviews with stakeholders from middle-income countries, since direct cues may hold less importance in work-related communications for East Asians compared to Americans.

This study has a number of strengths. We investigated the perceived barriers and facilitators to academia–industry collaboration in digital health, and interviewed stakeholders with varied experiences and affiliations who were knowledgeable and experienced in this field. Our sample of stakeholders from five countries, with different cultural and linguistic backgrounds, aimed to address the issues underlying academia–industry collaborations from a novel, cross-cultural perspective. Furthermore, the level of detail derived from qualitative interviews strengthened the study by providing in-depth descriptions of the stakeholders' experiences. The research team was trained prior to conducting the interviews, which allowed for more consistency and standardization across interviews.

There are also a number of limitations to this study. First, stakeholders from industry were primarily from China and our sample did not include anyone from low-income countries, which face unique challenges in developing and disseminating digital health technologies.[16,17] This limits our ability to draw broad conclusions about academia–industry collaborations in digital health across countries and cultures. Stakeholders may be reluctant to discuss more sensitive topics such as government funding, or lack thereof, as well as intellectual property, which may have contributed to the low frequencies of those themes in the discussion. Stakeholders were categorized into the mutually exclusive categories of "industry" and "academia", with the exception of one stakeholder who was active in both, but there may be many more perspectives such as those of government employees or

frontline healthcare workers. Interviews were conducted in two different languages as per the interviewee's preference and the coders had different levels of proficiency for each language. As such, the kappa score only indicated moderate agreement.

Technology and automation are widely expected to disrupt the current model of healthcare delivery in the coming years.[11] Although a majority of the academic partners in our study were affiliated with university medical centers, this was not among the issues discussed in the interviews—likely due to the lack of structured questions prompting discussions on this topic. In future studies, our understanding of academia–industry collaborations and discussions of specific strategies to remove barriers or strengthen facilitators must be framed within this context.

Conclusion

This study of academic stakeholders from the United States, China and other countries in the Asia-Pacific region as well as industry representatives predominantly from China showed that there is a strong need for academia–industry collaborations in the field of digital health and for increased planning and communication prior to and throughout these collaborations. Outlining each party's goals and expectations for timeline, adopting complementary roles and communicating about priorities will facilitate fruitful collaborations. As digital health technologies are widely disseminated, members of academia and industry could mutually benefit from authentic and strong partnerships that in turn can improve population health.

Contributorship: All co-authors were involved in study conceptualization, design, execution, analysis and interpretation. CL (Chelsea Liu) and SS searched the literature. SS, JPB, LLY and CL (Chang Liu) were involved in protocol development, gaining ethical approval, and participant recruitment. All co-authors contributed to manuscript development; all co-authors reviewed, edited and approved the final version of the manuscript, and agree to be accountable for all aspects of the work.

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Ethical approval: As stated in the Methods section, all study participants provided written informed consent to Duke Kunshan University to be interviewed.

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