

## Supplementary Material 2.

### Full description of insights from the qualitative open-text responses

#### ***Project 1: Military health screening - Government accountability and scientific rigor***

Several respondents viewed this project as necessary for ensuring individual safety and protecting service members' lives. Government accountability and expertise emerged as important justifications for MOH oversight. Respondents trusted MOH's role as both data custodian and health authority, seeing the ministry as providing a "second layer of credibility" and ensuring proper data protection. Many respondents viewed MOH as having the necessary expertise and public interest mandate to oversee such sensitive research, especially when genetic information could influence military career paths.

Scientific validity concerns were prominent, with respondents wanting MOH to ensure methodological rigor beyond genomic and health data alone. One respondent stated: "There should be other datasets to use that could determine outcomes how an individual's health could be affected during NS. It cannot be just health/DNA markers, it could be a confluence of habit, upbringing, living environment etc."

Respondent also raised concerns about unfair exclusion from military positions. Many worried that "genetics analysis to derive potential health risk and basis for deciding the suitable vocations may be stereotyping and therefore deprive suitable NS men from taking on certain vacation which actually he is well able to." The central value tension involved balancing individual safety with fairness principles. While recognizing legitimate safety concerns, respondents proposed alternatives like "subjecting them to more stringent health tests" rather than automatic exclusion based on genetic markers.

The other reasons for opposing MOH review were about perceptions on existing accountability and relevance. Some respondents felt that existing government oversight was sufficient and that "SAF (Singapore Armed Forces) can be trusted." Others questioned MOH's added value: "Unless MOH can demonstrate that they have a better understanding of the data that can value add to the research."

#### ***Project 2: Commercial accountability and national interests***

Commercial accountability and benefit-sharing emerged as central themes, with respondents demonstrating awareness of how private companies might exploit public data for profit. Some mentioned the need for reciprocal arrangements, suggesting "In return for sharing the data, Singapore should enjoy lower fees for accessing the research results".

Respondents emphasized data sovereignty concerns when foreign entities were involved, viewing international collaboration as requiring enhanced safeguards. Comments such as "Since the data resides with MOH, it should have the overall oversight and responsibility. Moreover, it is dealing with overseas company, there should be extra checks to ensure the legitimacy of the research, their ethics and system processes" reflected understanding that a different regulatory context posed additional risks. The foreign aspect was perceived as inherently requiring more oversight.

AI and technology concerns added another layer of complexity, with respondents expressing caution about emerging technologies. One respondent stated: "In a world of AI where we have not yet known its capabilities and future potential, we have every reason to be cautious in terms of feeding data and information into a private company... Data is the new gold in the future and we should not be giving away any data without understanding the entire purpose and having true transparency." This reflected broader anxieties about AI applications and the strategic value of health data.

Partnership and local capacity building were preferred alternatives to pure commercial arrangements. Some respondents questioned whether research could be conducted locally. This reflected desires to

balance international collaboration benefits with maintaining local control and capacity that could preserve Singapore's interests.

Reasons for opposing MOH review were limited and focused on efficiency concerns and trust in existing oversight. The few respondents primarily cited not seeing added value and concerns about research delays.

### ***Project 3: Privacy risks amplification and international data sharing concerns***

The rare disease scenario uniquely highlighted how small sample sizes amplify privacy risks. As one described: "Because it might be possible to link the data to the individuals since the disease is very rare... Sample size is small. Easy to identify." This mathematical privacy reasoning led respondents to view the 2-5 weeks MOH review delay as "a small consideration for this sensitivity." This reasoning also led to support for enhanced protections.

International data sharing concerns were significant, with respondents expressing wariness about overseas universities accessing Singapore data. The foreign entity aspect triggered calls for "additional oversight when data is shared offshore institutions" and concerns about researchers having "no obligation to abide by Singapore data protection act." Many respondents emphasized that "since the data is being used or viewed overseas, more protection should be done to the privacy of the patients." This reflected broader anxieties about data leaving Singapore's regulatory jurisdiction and the challenges of enforcing accountability across borders.

Despite privacy concerns, respondents also outlined the life-saving potential of rare disease research. Some advocated for expedited processes when lives were at stake: "If such a disease result in an immediate danger to the affected person, then I would agree that contact details of the patients should be kept and MOH to provide less scrutiny, in view of the lives at stake."

Stakeholder involvement expectations were high for this project, with respondents emphasizing that "patients should be consulted on their views and it should be taken into consideration." This reflected recognition that rare disease patients have unique stakes in research decisions and should have meaningful input into how their data is used. Respondents also stressed the importance of explicit consent: "There needs to be agreement from these patients to provide their data for this research proposal."

Enhanced security measures found strong support, with respondents endorsing CCTV monitoring despite potential research impediments. The reasoning was straightforward: "It is important that the privacy of patients is protected" outweighed concerns about making "research more difficult." Some respondents explicitly distrusted "researchers from an overseas university," viewing additional monitoring as necessary deterrent against potential misuse. The small patient population made any data breach particularly consequential, justifying what might otherwise seem like excessive security measures.

Opposition to MOH review was minimal and primarily focused on research efficiency concerns. Some respondents felt that with proper consent and safeguards, "there is no need to involve the government, and the process could be quicker." Others emphasized that for such a small, vulnerable population, the medical imperative of advancing rare disease research should take precedence over bureaucratic delays.

### ***Project 4: Strongest moral objections and social justice concerns***

Project 4 elicited the most ethically complex responses, with respondents expressing fundamental concerns about social stratification. The core concern centred on labelling and limiting children's potential: "We do not want to potentially pre-categorise children that causes trauma and unhelpful

labels. Children are sometimes able to excel beyond our imagination. Targeted education can be developed without genomics."

Many respondents expressed that the study should not be conducted at all. Strong reactions included "This research should not be conducted. You cannot choose your genes. Your level of success/education is not dictated by genes, but by the hard work put in" and "I don't agree with research predicting children education based on genetic information." Some respondents made historical parallels, with comments like "this sounds Nazi" and concerns about "Eugenics," reflecting deep discomfort with genetic-based categorization of human potential.

Social stratification and discrimination concerns were frequently raised, with respondents worried about creating "classes of society" and perpetuating inequality. Many feared that "once this is publicised, the general sentiment would be perceived to that of creating classes of society" and that the research was "in contradiction to the ethos of the government to build communities of diverse intellect intelligence and background." Respondents expressed concerns about "stigma, discrimination, racial profiling" and worried that genetic categorization would become self-fulfilling prophecies that could "cause the child or parent to give up on the child totally."

Respondents also questioned the reliability of the results from this project. Comments like "Gene sequence did not guarantee academic result. It will also depend on many factors such as social support system, grit, determination, etc" showed awareness that genetics represents only one factor among many. They also demonstrated understanding of the limitations of genetic prediction for complex traits: "Many children have done better in education even though their parents were less educated."

Psychological harm to children emerged as a major concern unique to this project. Respondents worried about "the psychological repercussions to students" and the impact of genetic labelling on children's self-perception and motivation. One respondent wrote: "When it comes to concluding how far a child is able to perform on a genome level and using that data to determine how far a child can go... is quite unfair." There were also concerns that genetic information might create reduced expectations that could harm children's developmental potential.

Reasons for supporting MOH review focused on preventing misuse and ensuring ethical oversight rather than supporting the research itself. Respondents wanted MOH involvement to "ensure that the study does not deviate from the original intended goal" and provide "additional perspective especially with regards to managing the cons described." Many viewed the research as requiring "layers of reviews before it is given the approval to commence" precisely because of its sensitive and potentially harmful nature. The genomic data was seen as "extra sensitive," requiring enhanced oversight.

Inter-agency coordination was viewed as important for this project, with respondents noting that "both ministries must bear responsibility for the agency that they govern" and that "any linkages from health data should be done with prudence and joint decision and responsibility of the respective ministries." Some questioned whether MOH was even the appropriate reviewer, asking "MOH is not the right ministry to be reviewing. Maybe MOE" should take the lead.

Opposition to MOH review was primarily based on jurisdictional concerns rather than support for the research. Some respondents felt that since this was an educational rather than health issue, "MOE can be trusted" to handle oversight independently. Others questioned MOH's relevant expertise for educational research. Notably, even people who opposed MOH review expressed fundamental scepticism about the research itself, suggesting that opposition to oversight was not necessarily endorsement of the project.