

**[Fig.3A] Distribution of phenotype refinement categories across IHPP measurement platforms**

<b>Platform</b>	<b>Abbreviation</b>	<b>Enhanced</b>	<b>Equal</b>	<b>Novel</b>
Anthropometry	ANT	53.70%	46.30%	0.00%
Bioelectricity	BIE	66.08%	33.92%	0.00%
Cell	CEL	8.06%	91.94%	0.00%
DXA body composition	DBC	32.36%	67.64%	0.00%
Eligibility Check	ELC	7.69%	92.31%	0.00%
Energy metabolism	ENM	0.00%	100.00%	0.00%
General physical examination with blood laboratory tests	PEX	12.36%	87.64%	0.00%
Health questionnaire	HEQ	12.09%	78.75%	9.16%
Metabolome	MBM	0.00%	99.56%	0.44%
Microbiome	MBI	0.00%	100.00%	0.00%
MRI & CT	MRICT	15.82%	84.18%	0.00%
Plasma metabolic factors and cytokines	PMC	0.00%	100.00%	0.00%
Proteome	PRO	0.00%	100.00%	0.00%
Psychology	PSY	12.70%	80.95%	6.35%
Pulmonary function	PUF	0.00%	100.00%	0.00%
Sensory	SEN	91.26%	8.74%	0.00%
Skin and its appendages	SIA	26.67%	73.33%	0.00%
Sleep	SLP	31.63%	64.29%	4.08%
Total RNA and small RNA	RNA	0.00%	100.00%	0.00%
Traditional Chinese Medicine	TCM	29.32%	24.81%	45.86%
Ultrasonography	USO	29.84%	70.16%	0.00%
Vocal	VOC	1.10%	98.90%	0.00%

Note: Distribution of Enhanced, Equal, and Novel refinement outcomes across IHPP platforms used in Figure 3A. Refinement categories (Enhanced, Equal, Novel) are defined based on combined feature- and qualifier-level mapping outcomes, as detailed in Table 2 and Methods in manuscript.

**[Fig.3A] Feature–qualifier mapping combinations underlying phenotype refinement categories**

<b>Platform</b>	<b>Feature Mapping Result</b>	<b>Combined Qualifier</b>	<b>Count</b>
Anthropometry	Exact	Exact	150
Anthropometry	Partial	Exact	139
Anthropometry	Partial	Partial	35
Bioelectricity	Exact	Exact	88
Bioelectricity	Exact	Partial	82
Bioelectricity	Exact	NA	9
Bioelectricity	Partial	Exact	65
Bioelectricity	Partial	Partial	42
Cell	Exact	Exact	1243
Cell	Partial	Exact	109
DXA body composition	Exact	Exact	416
DXA body composition	Exact	Partial	42
DXA body composition	Partial	Exact	127
DXA body composition	Partial	Partial	30
Eligibility Check	Exact	Exact	11
Eligibility Check	Exact	Partial	1
Eligibility Check	Exact	NA	1
Energy metabolism	Exact	Exact	4
Energy metabolism	Exact	NA	1
General physical examination with blood laboratory tests	Exact	Exact	78
General physical examination with blood laboratory tests	Partial	Exact	11
Health questionnaire	Exact	Exact	154
Health questionnaire	Exact	Partial	15
Health questionnaire	Exact	NA	167
Health questionnaire	Partial	Exact	41
Health questionnaire	Partial	Partial	10
Health questionnaire	Partial	NA	109
Health questionnaire	Unique	Exact	5
Health questionnaire	Unique	Partial	1
Health questionnaire	Unique	NA	44
MRI & CT	Exact	Exact	883
MRI & CT	Partial	Exact	135
MRI & CT	Partial	Partial	31
Metabolome	Exact	Exact	2021
Metabolome	Unique	Exact	9
Microbiome	Exact	Exact	1255
Plasma metabolic factors and cytokines	Exact	Exact	18
Proteome	Exact	Exact	16217
Psychology	Exact	Exact	82
Psychology	Exact	Partial	16
Psychology	Exact	NA	20
Psychology	Unique	NA	8

<b>Platform</b>	<b>Feature Mapping Result</b>	<b>Combined Qualifier</b>	<b>Count</b>
Pulmonary function	Exact	Exact	16
Sensory	Exact	Exact	123
Sensory	Exact	Partial	529
Sensory	Exact	NA	1
Sensory	Partial	Exact	114
Sensory	Partial	Partial	663
Sensory	Partial	NA	1
Skin and its appendages	Exact	Exact	44
Skin and its appendages	Exact	Partial	14
Skin and its appendages	Partial	Exact	2
Sleep	Exact	Exact	21
Sleep	Exact	Partial	6
Sleep	Exact	NA	148
Sleep	Partial	Exact	63
Sleep	Partial	Partial	24
Sleep	Partial	NA	20
Sleep	Unique	NA	12
Total RNA and small RNA	Exact	Exact	32083
Traditional Chinese Medicine	Exact	Exact	21
Traditional Chinese Medicine	Exact	Partial	17
Traditional Chinese Medicine	Exact	NA	11
Traditional Chinese Medicine	Partial	Exact	22
Traditional Chinese Medicine	Partial	NA	1
Traditional Chinese Medicine	Unique	Exact	12
Traditional Chinese Medicine	Unique	Partial	1
Traditional Chinese Medicine	Unique	Unique	1
Traditional Chinese Medicine	Unique	NA	47
Ultrasonography	Exact	Exact	174
Ultrasonography	Exact	Partial	13
Ultrasonography	Partial	Exact	43
Ultrasonography	Partial	Partial	18
Vocal	Exact	Exact	171
Vocal	Exact	NA	5
Vocal	Partial	Exact	2
Vocal	Partial	NA	3

Note: Counts of phenotype instances stratified by feature- and qualifier-level mapping outcomes for each measurement platform, derived from the controlled vocabularies of features and qualifiers (Table S1 and S2). These combinations constitute the basis for categorizing refinement outcomes as Enhanced, Equal, or Novel in Figure 3A.

**[Fig.3B] Source-mapping proportions by feature class**

<b>Feature classification</b>	<b>Source Type</b>	<b>Count</b>	<b>Total</b>	<b>Proportion</b>
Ex vivo measurement	Database	50442	53109	0.950
Ex vivo measurement	Dataset	0	53109	0.000
Ex vivo measurement	Literature	1688	53109	0.032
Ex vivo measurement	Ontology	970	53109	0.018
Ex vivo measurement	Unique	9	53109	0.000
In vivo measurement	Database	0	909	0.000
In vivo measurement	Dataset	0	909	0.000
In vivo measurement	Literature	319	909	0.351
In vivo measurement	Ontology	590	909	0.649
In vivo measurement	Unique	0	909	0.000
Questionnaire measurement	Dataset	574	730	0.786
Questionnaire measurement	Literature	12	730	0.016
Questionnaire measurement	Ontology	19	730	0.026
Questionnaire measurement	Unique	125	730	0.171

Note: For each feature class, counts and percentages summarize mappings to the four external source types (database, ontology, literature, and dataset) recorded in the controlled vocabulary (CV). Proportions are calculated as  $\text{Count} / \text{Total}$  within each feature class and correspond to the feature-class percentages shown in Figure 3B. “Unique” denotes terms without an external source mapping.

**[Fig.3B] Source-mapping proportions by qualifier class**

Qualifier classification	Source Type	Count	Total	Proportion
ST	Literature	3	14	0.214
ST	Ontology	11	14	0.786
HAP	Literature	3	221	0.014
HAP	Ontology	218	221	0.986
ORP	Ontology	24	24	1.000
MM	Literature	12	29	0.414
MM	Ontology	13	29	0.448
MM	Unique	4	29	0.138
MC	Dataset	52	396	0.131
MC	Literature	33	396	0.083
MC	Ontology	303	396	0.765
MC	Unique	8	396	0.020
MID	Dataset	8	40	0.200
MID	Literature	6	40	0.150
MID	Ontology	26	40	0.650
SI	Literature	9	23	0.391
SI	Ontology	12	23	0.522
SI	Unique	2	23	0.087
MU	Literature	14	71	0.197
MU	Ontology	57	71	0.803
OT	Dataset	2	3	0.667
OT	literature	1	3	0.333
AS	Literature	3	14	0.214
AS	Ontology	11	14	0.786

Note: For each qualifier class, counts and percentages summarize mappings to the four external source types (database, ontology, literature, and dataset) recorded in the controlled vocabulary (CV). Proportions are calculated as Count / Total within each qualifier class and correspond to the qualifier-class percentages shown in Figure 3B. “Unique” denotes terms without an external source mapping.