

Editorial

Acharjee, Animesh; Agarwal, Prason; Gkoutos, Georgios

DOI:

[10.3389/fendo.2023.1266557](https://doi.org/10.3389/fendo.2023.1266557)

License:

Creative Commons: Attribution (CC BY)

Document Version

Publisher's PDF, also known as Version of record

Citation for published version (Harvard):

Acharjee, A, Agarwal, P & Gkoutos, G 2023, 'Editorial: Integrative Multi-Modal and Multi-Omics Analytics for the Better Understanding of Metabolic Diseases', *Frontiers in Endocrinology*, vol. 14, 1266557.
<https://doi.org/10.3389/fendo.2023.1266557>

[Link to publication on Research at Birmingham portal](#)

General rights

Unless a licence is specified above, all rights (including copyright and moral rights) in this document are retained by the authors and/or the copyright holders. The express permission of the copyright holder must be obtained for any use of this material other than for purposes permitted by law.

- Users may freely distribute the URL that is used to identify this publication.
- Users may download and/or print one copy of the publication from the University of Birmingham research portal for the purpose of private study or non-commercial research.
- User may use extracts from the document in line with the concept of 'fair dealing' under the Copyright, Designs and Patents Act 1988 (?)
- Users may not further distribute the material nor use it for the purposes of commercial gain.

Where a licence is displayed above, please note the terms and conditions of the licence govern your use of this document.

When citing, please reference the published version.

Take down policy

While the University of Birmingham exercises care and attention in making items available there are rare occasions when an item has been uploaded in error or has been deemed to be commercially or otherwise sensitive.

If you believe that this is the case for this document, please contact UBIRA@lists.bham.ac.uk providing details and we will remove access to the work immediately and investigate.



OPEN ACCESS

EDITED AND REVIEWED BY
Tom Michael,
University of Bergen, Norway

*CORRESPONDENCE
Animesh Acharjee
✉ a.acharjee@bham.ac.uk

RECEIVED 25 July 2023
ACCEPTED 21 August 2023
PUBLISHED 08 September 2023

CITATION
Acharjee A, Agarwal P and Gkoutos GV
(2023) Editorial: Integrative multi-modal,
multi-omics analytics for the better
understanding of metabolic diseases.
Front. Endocrinol. 14:1266557.
doi: 10.3389/fendo.2023.1266557

COPYRIGHT
© 2023 Acharjee, Agarwal and Gkoutos. This
is an open-access article distributed under
the terms of the [Creative Commons
Attribution License \(CC BY\)](https://creativecommons.org/licenses/by/4.0/). The use,
distribution or reproduction in other
forums is permitted, provided the original
author(s) and the copyright owner(s) are
credited and that the original publication in
this journal is cited, in accordance with
accepted academic practice. No use,
distribution or reproduction is permitted
which does not comply with these terms.

Editorial: Integrative multi-modal, multi-omics analytics for the better understanding of metabolic diseases

Animesh Acharjee^{1,2,3,4*}, Prasoon Agarwal⁵
and Georgios V. Gkoutos^{1,2,3,4,6}

¹College of Medical and Dental Sciences, Institute of Cancer and Genomic Sciences, University of Birmingham, Birmingham, United Kingdom, ²Institute of Translational Medicine, University Hospitals Birmingham National Health Service (NHS) Foundation Trust, Birmingham, United Kingdom, ³Medical Research Council (MRC) Health Data Research United Kingdom (UK) (HDR), Midlands Site, Birmingham, United Kingdom, ⁴Centre for Health Data Research, University of Birmingham, Birmingham, United Kingdom, ⁵National Bioinformatics Infrastructure Sweden (NBIS), Science for Life Laboratory, Division of Occupational and Environmental Medicine, Department of Laboratory Medicine, Lund University, Lund, Sweden, ⁶Cancer Research, National Institute for Health and Care Research (NIHR) Experimental Cancer Medicine Centre, Birmingham, United Kingdom

KEYWORDS

omics, diagnostic, biomarker, therapeutic, metabolic disease

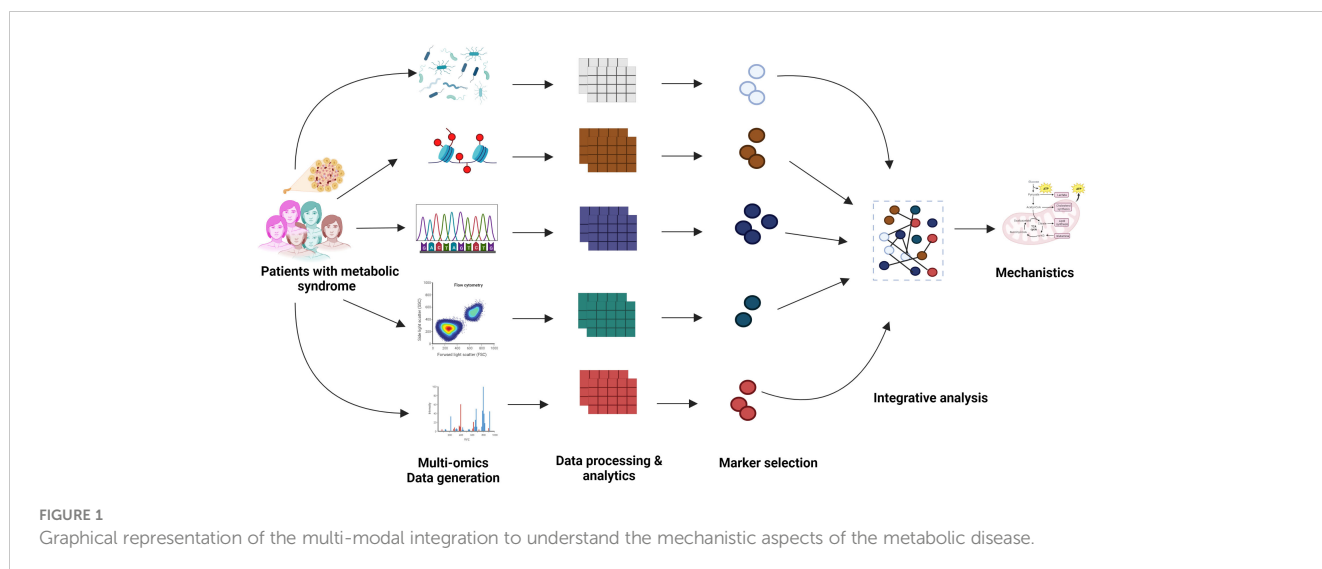
Editorial on the Research Topic

Integrative multi-modal, multi-omics analytics for the better understanding of metabolic diseases

In the past few years, large-scale, high-throughput multi-omics experiments and improved clinical measurements have led to the generation of a plethora of multi-modal datasets related to various metabolic diseases (MetS), for example, type 1 diabetes (T1D), obesity, non-alcoholic fatty liver disease (NAFLD), etc. Many integration strategies have been discussed in the literature, such as early, intermediate, and late integration (1). The process of early integration involves merging multiple omics information sources into a unified matrix, whereas intermediate integration involves transforming the source datasets into representations that are both common and specific to omics. Late integration consists of the individual analysis of each omics dataset, followed by the combination of their respective predictions to obtain a result (1). **Figure 1** shows an example of late integration described in the context of MetS.

This editorial summarizes the contributions to the Research Topic of Frontiers in Endocrinology, “*Integrative Multi-Modal, Multi-Omics Analytics for the Better Understanding of Metabolic Diseases*”, between November 2021 and July 2023. This Research Topic aims to provide a platform for researchers in multi-omics and multi-modal analysis of metabolic diseases to identify targets for therapy and diagnosis. A total of 10 original articles were selected for publication from the submissions received. A summary of each manuscript is detailed below.

We have grouped the papers based on the different types of diseases they address, starting with hyperlipidemia, which is characterized by elevated levels of lipids, for example, cholesterol and triglycerides. The study performed by **Zhai et al.** investigated



the effects of policosanol on the control of hyperlipidemia, gut microbiome composition, and metabolic status using a C57BL/6 mouse model. Serum triglycerides, total cholesterol, and brown adipose tissue weight were all shown to be dramatically reduced after policosanol administration. Overall, policosanol demonstrated to the potential to alter the makeup of the gut microbiota, speed up fat breakdown, and differentiate thermogenesis-related gene activity.

It has been noted that vitamin D also affects patients with metabolic syndrome, and [Amirkhizi et al.](#) conducted a case-control study to investigate the relationship between vitamin D deficiency and adipokines, atherogenesis indicators, and metabolic syndrome factors in 195 patients with metabolic syndrome. The study demonstrated that patients with MetS and vitamin D insufficiency (cases) had higher AIP and LAP than controls. Moreover, vitamin D deficiency was correlated with some of the cardiometabolic risk factors in patients with MetS.

T1D is characterized by multiple factors, i.e., genetics, lifestyle, and metabolism. [Clos-Garcia et al.](#) investigated the gut microbiome and blood metabolome in individuals with T1D and healthy controls. The study stratified T1D cases based on albuminuria levels, identifying 51 species with and without albuminuria. Plasma metabolomics analysis identified differences in steroidogenesis, glucose metabolism, and circulating sphingolipids in subjects with T1D. Furthermore, the analysis revealed reduced interactions between the gut microbiome and plasma metabolome profiles, while polar metabolite, lipid, and bacteriome compositions contributed to the variance in albuminuria levels among T1D individuals. [Zhang et al.](#) analyzed the serum metabolic profiles of children with T1D diabetes and healthy controls and identified many differential metabolites, such as carbohydrates, indoles, unsaturated fatty acids, amino acids, and organic acids, consistently across pediatric patients.

The transcriptome and proteome also play a role in MetS, for example, in patients with non-alcoholic steatohepatitis (NASH). [Pyo and Choi](#) found that upregulated genes were associated with inflammation, steatosis, apoptosis, and extracellular matrix organization, while downregulated genes were associated with the

response to metal ions and lipid and amino acid metabolism. Functional enrichment analysis revealed amino acid metabolism as the most significant hepatic perturbation in both human and mouse NASH.

[Wang et al.](#) developed a new obesity measurement index for metabolically associated fatty liver disease (MAFLD), which includes traditional BMI. The results showed a strong correlation between MAFLD, traditional BMI, and the new index.

Epithelial-mesenchymal transition (EMT) is a critical event in the migration and invasion of endometriosis, involving immune and stromal cells. [Quan et al.](#) investigated the potential use of EMT-based classification for the precise diagnosis and treatment of peritoneal endometriosis. A total of 76 peritoneal endometriosis samples were classified into two clusters based on EMT hallmark genes. EMT scores and abundances were compared, and a diagnostic model was constructed based on 9 markers related to immune and stromal scores.

[Pan et al.](#) developed a targeted method for the accurate quantification of 80 bile acids in gastric cancer patients with the aim of developing diagnostics for the early screening of GC. The panel of six bile acids (ratio), which included HCA, TLCA, NorCA, DCA-3G, TLCA-3S, and HDCA/LCA, showed high accuracy for the diagnosis of gastric cancer.

[Yuan et al.](#) investigated the causal relationship between rheumatoid arthritis (RA) and atlantoaxial subluxation (AAS), identifying and quantifying the potential involvement of C-reactive protein as a mediator. The researchers utilized a genome-wide association study, a two-sample Mendelian randomization (MR) analysis of genetically predicted rheumatoid arthritis, and an AAS. The MR analysis revealed a higher genetically predicted risk of rheumatoid arthritis and an increased risk of AAS. There was no convincing evidence that genetically predicted AAS affected the risk of rheumatoid arthritis.

[Pirzada et al.](#) used machine learning to discover potential inhibitors of GSK3, a protein involved in the replication and assembly of the nucleocapsid protein of SARS-CoV-2 and other coronaviruses. They used a dataset of FDA-approved and investigational pharmaceuticals from the ChEMBL database and a variety of molecular descriptors to define the inhibitors. Based on

their predicted activity, selinexor and ruboxistaurin were identified as the two most promising candidates. The study demonstrated that this virtual high-throughput screening approach based on artificial intelligence can accelerate drug discovery and identify novel targets.

In summary, this Research Topic presented multiple MetS-related studies. Multi-omics and multi-modal datasets, such as clinical data (Clos-Garcia et al.), transcriptomics (Pyo and Choi), metabolomics (Clos-Garcia et al.), and gut microbiome datasets (Clos-Garcia et al.), have been utilized to understand metabolic diseases. Thus, the results of these studies improve the prospects for future therapeutic and translational studies (2).

Author contributions

AA: Conceptualization, Funding acquisition, Investigation, Supervision, Visualization, Writing – original draft, Writing – review & editing, Formal Analysis, Methodology, Validation. PA: Conceptualization, Data curation, Investigation, Writing – original draft, Writing – review & editing. GG: Conceptualization, Funding acquisition, Investigation, Writing – original draft, Writing – review & editing.

Funding

The authors acknowledge support from the NIHR Birmingham ECMC, NIHR Birmingham SRMRC, Nanocommons H2020-EU (731032), MAESTRIA (Grant agreement ID 965286),

References

1. Picard M, Scott-Boyer MP, Bodein A, Périn O, Droit A. Integration strategies of multi-omics data for machine learning analysis. *Comput Struct Biotechnol J* (2021) 19:3735–46. doi: 10.1016/j.csbj.2021.06.030
2. Bravo-Merodio L, Acharjee A, Russ D, Bisht V, Williams JA, Tsaprouni LG, et al. Translational biomarkers in the era of precision medicine. *Adv Clin Chem* (2021) 102:191–232. doi: 10.1016/bs.acc.2020.08.002

HYPERMARKER (Grant agreement ID 101095480), PARC (Grant Agreement No. 101057014), and the MRC Heath Data Research UK (HDRUK/CFC/01), an initiative funded by UK Research and Innovation, the Department of Health and Social Care (England) and the devolved administrations, and leading medical research charities. The views expressed in this publication are those of the authors and do not necessarily represent those of the NHS, the National Institute for Health Research, the Medical Research Council, or the Department of Health.

Conflict of interest

The authors declare that the research was conducted in the absence of any commercial or financial relationships that could be construed as a potential conflict of interest.

The authors declared that they were an editorial board member of *Frontiers*, at the time of submission. This had no impact on the peer review process and the final decision.

Publisher's note

All claims expressed in this article are solely those of the authors and do not necessarily represent those of their affiliated organizations, or those of the publisher, the editors and the reviewers. Any product that may be evaluated in this article, or claim that may be made by its manufacturer, is not guaranteed or endorsed by the publisher.