nature portfolio

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Reporting Summary

Nature Portfolio wishes to improve the reproducibility of the work that we publish. This form provides structure for consistency and transparency in reporting. For further information on Nature Portfolio policies, see our Editorial Policies and the Editorial Policy Checklist.

Statistics

For all statistical analyses, confirm that the following items are present in the figure legend, table legend, main text, or Methods section.

n/a	Confirmed	
☐	☒	The exact sample size (*n*) for each experimental group/condition, given as a discrete number and unit of measurement
☐	☒	A statement on whether measurements were taken from distinct samples or whether the same sample was measured repeatedly
☐	☒	The statistical test(s) used AND whether they are one- or two-sided *Only common tests should be described solely by name; describe more complex techniques in the Methods section.*
☒	☐	A description of all covariates tested
☒	☐	A description of any assumptions or corrections, such as tests of normality and adjustment for multiple comparisons
☐	☒	A full description of the statistical parameters including central tendency (e.g. means) or other basic estimates (e.g. regression coefficient) AND variation (e.g. standard deviation) or associated estimates of uncertainty (e.g. confidence intervals)
☐	☒	For null hypothesis testing, the test statistic (e.g. *F*, *t*, *r*) with confidence intervals, effect sizes, degrees of freedom and *P* value noted *Give P values as exact values whenever suitable.*
☒	☐	For Bayesian analysis, information on the choice of priors and Markov chain Monte Carlo settings
☒	☐	For hierarchical and complex designs, identification of the appropriate level for tests and full reporting of outcomes
☒	☐	Estimates of effect sizes (e.g. Cohen's *d*, Pearson's *r*), indicating how they were calculated

Our web collection on statistics for biologists contains articles on many of the points above.

Software and code

Policy information about availability of computer code

Data collection	FACS Aria II (BD), OctetRED96e system (ForteBio), ARVO X3 (PerkinElmer), CryoSPARC (Structura Biotechnology Inc.), BZ-X700 (Keyence)
Data analysis	FlowJo v10.5.3 (BD), Prism 11 (GraphPad), Octet BLI Analysis 12.2.13.5 (ForteBio), UCSF Chimera X (Resource for Biocomputing, Visualization, and Informatics), COOT (MRC laboratory of molecular biology), iSOLDE (ALTOS Labs), Servalcat (MRC laboratory of molecular biology)

For manuscripts utilizing custom algorithms or software that are central to the research but not yet described in published literature, software must be made available to editors and reviewers. We strongly encourage code deposition in a community repository (e.g. GitHub). See the Nature Portfolio guidelines for submitting code & software for further information.

Data

Policy information about availability of data

All manuscripts must include a data availability statement. This statement should provide the following information, where applicable:

- Accession codes, unique identifiers, or web links for publicly available datasets
- A description of any restrictions on data availability
- For clinical datasets or third party data, please ensure that the statement adheres to our policy

Source data supporting the findings of this study are available within the article and Supplementary Information files. The structural data have been deposited in the Electron Microscopy Data Bank (EMDB) with IDs EMD-61568 and EMD-61569 and in the Protein Data Bank (PDB) with ID 9JKR. The remaining data are available within the Article, Supplementary Information, or Source Data file.

Research involving human participants, their data, or biological material

Policy information about studies with human participants or human data. See also policy information about sex, gender (identity/presentation), and sexual orientation and race, ethnicity and racism.

Reporting on sex and gender	Information on participants' sex was obtained from their clinical medical records. A total of 19 males and 9 females participated in the study. Sex-based analyses were not performed.
Reporting on race, ethnicity, or other socially relevant groupings	All samples analyzed in this study were obtained from Japanese patients. Other social backgrounds were not collected.
Population characteristics	Age: 20's (n = 1), 30's (n = 1), 40's (n = 5), 50's (n = 7), 60's (n = 10), and 70's (n = 4). Disease severity score: DSS1 (n = 6), DSS2 (n = 8), DSS3 (n = 6), DSS4 (n = 3), DSS5 (n = 5).
Recruitment	Patients were enrolled through public recruitment at NHO Kinki Chuo Chest Medical Center and The University of Osaka from July 2017 to October 2021. No financial compensation was provided to participants.
Ethics oversight	The study protocol was approved by the institutional review board of NHO Kinki Chuo Chest Medical Center (permission #559) and The University of Osaka (permission #781-4). All volunteers provided written informed consent in accordance with the Declaration of Helsinki.

Note that full information on the approval of the study protocol must also be provided in the manuscript.

Field-specific reporting

Please select the one below that is the best fit for your research. If you are not sure, read the appropriate sections before making your selection.

☒ Life sciences ☐ Behavioural & social sciences ☐ Ecological, evolutionary & environmental sciences

For a reference copy of the document with all sections, see nature.com/documents/nr-reporting-summary-flat.pdf

Life sciences study design

All studies must disclose on these points even when the disclosure is negative.

Sample size	No sample size calculation was performed. The final number of samples was determined by either pilot experiments or previous similar experiments. The sample sizes are sufficient to measure statistical significance using appropriate methods described in the study. Experiments are repeated to substantiate the rigor of the findings.
Data exclusions	No data were excluded from the analyses.
Replication	Experiments were independently replicated at least two times with consistent results.
Randomization	Randomization is not relevant to our study.
Blinding	The investigators were not blinded in the experiments due to the design of the study.

Reporting for specific materials, systems and methods

We require information from authors about some types of materials, experimental systems and methods used in many studies. Here, indicate whether each material, system or method listed is relevant to your study. If you are not sure if a list item applies to your research, read the appropriate section before selecting a response.

Materials & experimental systems

n/a	Involved in the study
☐	☒ Antibodies
☐	☒ Eukaryotic cell lines
☒	☐ Palaeontology and archaeology
☐	☒ Animals and other organisms
☐	☒ Clinical data
☒	☐ Dual use research of concern
☒	☐ Plants

Methods

n/a	Involved in the study
☒	☐ ChIP-seq
☐	☒ Flow cytometry
☒	☐ MRI-based neuroimaging

Antibodies

Antibodies used	Flow Cytometory:

Antibody	Supplier	Catalog	Dilution
1. Anti-human CD38-FITC	Thermo Fisher Scientific	Cat#11-0388-42	1:50
2. Anti-human IgL-PE	Thermo Fisher Scientific	Cat#12-9990-42	1:20
3. Streptavidin-APC prelabelled with fluorophore-conjugated streptavidin)	Thermo Fisher Scientific	Cat#SA1005	1:250 (biotinylated GM-CSF
4. Anti-human Fc Receptor binding inhibitor	Thermo Fisher Scientific	Cat#14-9161-73	1:200
5. Anti-human IgD-PE-Cy7	BioLegend	Cat#348209	1:200
6. Anti-human CD27-APC-Cy7	BioLegend	Cat#356424	1:100
7. Anti-human CD19-BV785	BioLegend	Cat#302240	1:200
8. Streptavidin-BV421 prelabelled with fluorophore-conjugated streptavidin)	BioLegend	Cat#405225	1:50 (biotinylated GM-CSF
9. Anti-human IgG-BV510	BD	Cat#563247	1:10
10. Propidium iodide	Sigma-Aldrich	Cat#537060	1:10000
11. Anti-human IgG	BD	Cat#555784	1:50
ELISA:			
12. anti-human IgG-horseradish peroxidase-conjugated	Southern Biotech	Cat#2044-05	1:3000

Validation

All commercial antibodies used in this study were validated by the manufacturers and supported by previous literature for specificity in the indicated applications, and validation data are available on the manufacturers's websites:
1. https://www.thermofisher.com/antibody/product/CD38-Antibody-clone-HB7-Monoclonal/11-0388-42
2. https://www.thermofisher.com/antibody/product/Lambda-light-chain-Antibody-clone-1-155-2-Monoclonal/12-9990-42
3. https://www.thermofisher.com/order/catalog/product/SA1005
4. https://www.thermofisher.com/antibody/product/Fc-Receptor-Binding-Inhibitor-Antibody-Polyclonal/14-9161-73
5. https://www.biolegend.com/ja-jp/products/pe-cyanine7-anti-human-igd-antibody-6996
6. https://www.biolegend.com/de-de/products/apc-cyanine7-anti-human-cd27-antibody-12841
7. https://www.biolegend.com/fr-fr/products/brilliant-violet-785-anti-human-cd19-antibody-7967
8. https://www.biolegend.com/ja-jp/products/brilliant-violet-421-streptavidin-7297
9. https://www.bdbiosciences.com/ja-jp/products/reagents/flow-cytometry-reagents/research-reagents/single-color-antibodies-ruo/bv510-mouse-anti-human-igg.563247?tab=product_details
10. https://www.sigmaaldrich.com/JP/ja/product/mm/537060?srsltid=AfmBOorh3HkslfGVr9KWpmkIIBBTdNjkfq6U4xNI2xtneOv5i5Bq-E_o
11. https://www.bdbiosciences.com/ja-jp/products/reagents/flow-cytometry-reagents/research-reagents/single-color-antibodies-ruo/purified-mouse-anti-human-igg.555784?tab=product_details
12. https://www.southernbiotech.com/goat-anti-human-igg-fc-hrp-2048-05

Eukaryotic cell lines

Policy information about cell lines and Sex and Gender in Research

Cell line source(s)	TF-1 cells were from ATCC (CRL-2003). TF-1 cells were isolated from bone marrow derived from a 35-year-old Asian male with severe pancytopenia.
Authentication	The cell line was not authenticated.
Mycoplasma contamination	The cell line was not tested for mycoplasma contamination.
Commonly misidentified lines (See ICLAC register)	n/a

Animals and other research organisms

Policy information about studies involving animals; ARRIVE guidelines recommended for reporting animal research, and Sex and Gender in Research

Laboratory animals	Rag2tm1.1Flv Csf2/Il3tm1.1(CSF2,IL3)Flv Il2rgtm1.1Flv/J mice were obtained from Jackson laboratory (strain #014595).
Wild animals	n/a
Reporting on sex	Both male and female mice were included in this study. No sex-based analysis was performed.
Field-collected samples	n/a
Ethics oversight	All animal experiments were approved by the Animal Research Committee of Immunology Frontier Research Center, The University of Osaka (R1-02-1) and conducted in accordance with the guidelines of the committee.

Note that full information on the approval of the study protocol must also be provided in the manuscript.

Clinical data

Policy information about clinical studies

All manuscripts should comply with the ICMJE guidelines for publication of clinical research and a completed CONSORT checklist must be included with all submissions.

Clinical trial registration	n/a
Study protocol	n/a
Data collection	n/a
Outcomes	n/a

Plants

Seed stocks	*Report on the source of all seed stocks or other plant material used. If applicable, state the seed stock centre and catalogue number. If plant specimens were collected from the field, describe the collection location, date and sampling procedures.*
Novel plant genotypes	*Describe the methods by which all novel plant genotypes were produced. This includes those generated by transgenic approaches, gene editing, chemical/radiation-based mutagenesis and hybridization. For transgenic lines, describe the transformation method, the number of independent lines analyzed and the generation upon which experiments were performed. For gene-edited lines, describe the editor used, the endogenous sequence targeted for editing, the targeting guide RNA sequence (if applicable) and how the editor was applied.*
Authentication	*Describe any authentication procedures for each seed stock used or novel genotype generated. Describe any experiments used to assess the effect of a mutation and, where applicable, how potential secondary effects (e.g. second site T-DNA insertions, mosiacism, off-target gene editing) were examined.*

Flow Cytometry

Plots

Confirm that:

☒ The axis labels state the marker and fluorochrome used (e.g. CD4-FITC).

☒ The axis scales are clearly visible. Include numbers along axes only for bottom left plot of group (a 'group' is an analysis of identical markers).

☒ All plots are contour plots with outliers or pseudocolor plots.

☒ A numerical value for number of cells or percentage (with statistics) is provided.

Methodology

Sample preparation	Human plasma and PBMCs were isolated from whole blood using Ficoll-Paque density gradient centrifugation (#GE17-1440-03; GE Healthcare) according to the manufacturer's instructions and the cells were stored in CELLBANKER 1 (#11910; Takara Bio) at −80°C. Cryopreserved PBMCs were thawed at 37°C and immediately washed with PBS containing 2% FBS, followed by staining with GM-CSF probes and antibodies in PBS with 2% FBS for 20 min at 4°C. Single-cell suspensions of PBMCs were analyzed and GM-CSF-specific B cells were sorted on a FACSAria II (BD).
Instrument	FACSAria II (BD)
Software	FlowJo v10.10.1 (BD)
Cell population abundance	The description of the methods used in sorting and the methods to evaluate the function of the samples derived from the sorted cells ensure the purity of the sorted cells.
Gating strategy	The gating strategy for human PBMCs: 1. Lymphocytes in FSC-A/SSC-A plot. 2. Single cells in FCS-H/FCS-W and SSC-H/SSC-W plots. 3. Live CD19+ cells in CD19/PI plot. 3-1. GM-CSF+ cells in APC-GM-CSF/BV421-GM-CSF plot, then IgG+ cells in IgG/IgD plot. 3-2. IgG+ cells in IgG/IgD plot, then GM-CSF+ IgG+ cells in APC-GM-CSF/BV421-GM-CSF plot.

☒ Tick this box to confirm that a figure exemplifying the gating strategy is provided in the Supplementary Information.