Danielle C. M. Belgrave

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Profile

My research focuses on Bayesian and statistical machine learning within the healthcare domain to understand disease heterogeneity to develop personalised disease treatment and management strategies. I am currently developing and implementing methods which incorporate medical domain knowledge with data-driven models. My research interests include latent variable modelling, longitudinal data analysis methods, survival modelling, 'omics data, handling missing data, dimensionality reduction techniques, Bayesian graphical models and clustering.

PROFESSIONAL CAREER

Consultancy Contracts

Microsoft Research Cambridge **June 2017 – August 2017**
Visiting Researcher (AI in Healthcare)

GlaxoSmithKline **October 2015 – September 2016**
Consultant Statistician

Visiting Research Fellow — September 2016 – January 2017

University of Melbourne
Project: Dimensionality reduction of 'omics data to understand longitudinal disease profiles

Researcher — October 2017 – Present

Microsoft Research Cambridge (UK) **Machine Learning for Healthcare**
Development and implementation of probabilistic graphical models to understand health

Research Fellow (Tenured Academic Position) — 2015 – Present

Imperial College London **Award: MRC Career Development Award in Biostatistics**
Project Title: Unified probabilistic latent variable modelling strategies to accelerate endotype discovery in longitudinal studies

- Research, design and implement novel, highly scalable machine learning models with a focus on longitudinal, high-dimensional data
- Develop probabilistic and graphical machine learning models and in the context of disease development
- Develop latent variable modelling strategies for distinguishing subtypes of disease using deep learning
- Develop predictive modelling strategies for understanding distinct biomarkers and environmental characteristics to develop personalised healthcare strategies
- Support strategic decision making with regard to various science problems
- Promote collaborative research with interdisciplinary research team
- Lead research of 3 postdoctoral research associates and a clinical research fellow
- Programming Skills: R, Python, Stata, C# (working knowledge)

Principal Statistician **2014 – 2015**
GlaxoSmithKline
Respiratory Medicine

- Developing statistical models to better understand the mechanisms of COPD
- Influencing and providing statistical contributions and relevant analyses to support clinical development plans, regulatory and commercial strategies
- Developing and implementing longitudinal models to investigate drug efficacy and safety in patients with COPD
- **Awarded the GSK Exceptional Science Award** for Excellence in Statistical Methodology work

Honorary Research Fellow in Machine Learning **2014 – 2017**
Postdoctoral Research Associate in Statistics **2013 – 2014**
Research Assistant in Statistics **2008 – 2013**
University of Manchester
Department of Respiratory Medicine and Centre for Health Informatics

- Successfully conceived and developed statistical machine learning models to determine the relationship between genotype and phenotype in asthma and allergies and how it is modulated by risk factors and predictors
- Implemented and published probabilistic models for analysing the timing and occurrence of events and modelling change over time for longitudinal data
- Successfully collaborated with clinicians and scientific researchers to provide optimal modelling strategies for research questions

EDUCATION

PhD (Subject Area: Medical Statistics and Machine Learning) **2010 – 2013**
The University of Manchester
Thesis: Probabilistic causal models for asthma and allergies developing in childhood
Supervisors: Professor Iain Buchan, Professor Christopher Bishop, Professor Adnan Custovic
MSc Statistics - University College London
BSc Business Mathematics and Statistics - London School of Economics

AWARDS

- Travel Award Women in Machine Learning (December 2016)
- Travel Award for the European Academy of Allergy and Clinical Immunology (June 2016)
- Sysbio2016 Young Investigator's Award (February 2016)
- GSK Exceptional Science Award for Statistical Methodology work in Respiratory Medicine (August 2015)
- GSK Bronze Medal Award of Recognition (February 2015)
- MRC Strategic Skills Fellowship – Career Development Award in Biostatistics (2015 – 2018)
- Microsoft Research PhD Scholarship Program - Dorothy Hodgkin Postgraduate Award (October 2010 – October 2013).
- Selected to attend the 61st Nobel Laureates in Physiology and Medicine Meeting in Lindau. (sponsored by Microsoft and Boehringer-Ingelheim) (June 2010).
  Included being selected with 20 other researchers to present research to Bill Gates

- Prize for Best Poster presentation for the European Academy of Allergy and Clinical Immunology (June 2013)
- Barry Kay Award from the British Society of Allergy and Clinical Immunology for best research presentation (July 2012)
- Prize for Best Oral abstract presentation for the Chiesi Respiration Forum (November 2010)
- Prize for Best Oral abstract presentation for the European Academy of Allergy and Clinical Immunology (June 2010)

PUBLICATIONS

https://scholar.google.co.uk/citations?user=bGDCgpUAAAAJ&hl=en

1. **Belgrave D**, Granell R, Turner SW, Curtin JA, Buchan IE, Le Souëf PN, Simpson A, Henderson AJ, Custovic A. Lung function trajectories from pre-school age to adulthood and their associations with early life factors: a retrospective analysis of three population-based birth cohort studies. The Lancet Respiratory Medicine, 2018 *(article in press)*.
2. Howard R, **Belgrave D**, Papastamoulis P, Simpson A, Rattray M, Custovic A. Evolution of IgE responses to multiple allergen components throughout childhood. Journal of Allergy and Clinical Immunology, 2018 *(article in press)*.
3. Custovic A., **Belgrave D**., Lin L., Bakhsoliani E., Telcian A.G., Solari, R., Murray C.S., Walton R.P., Curtin J., Edwards M.R. and Simpso, A., 2018. Cytokine Responses to Rhinovirus and Development of Asthma, Allergic Sensitization and Respiratory Infections during Childhood. American journal of respiratory and critical care medicine, 2018 *(article in press)*.
4. Deliu, M., Sperrin, M., **Belgrave D** and Custovic, A., 2016. Identification of asthma subtypes using clustering methodologies. Pulmonary therapy, 2(1), pp.19-41.
5. Deliu, M., **Belgrave D**, Sperrin, M., Buchan, I. and Custovic, A., 2017. Asthma phenotypes in childhood. Expert review of clinical immunology, 13(7), pp.705-713.
6. Wickman, M., Lupinek, C., Andersson, N., **Belgrave D**, Asarnoj, A., Benet, M., Pinart, M., Wieser, S., Garcia-Aymerich, J., Baar, A. and Pershagen, G., 2017. Detection of IgE reactivity to a handful of allergen molecules in early childhood predicts respiratory allergy in adolescence. EBioMedicine.
7. Ihuoma, H., **Belgrave D**, Murray, C.S., Foden, P., Simpson, A. and Custovic, A., 2017. Cat ownership, cat allergen exposure, and trajectories of sensitization and asthma throughout childhood. Journal of Allergy and Clinical Immunology.
8. **Belgrave D** and Custovic, A., 2016. The importance of being earnest in epidemiology. Acta Paediatrica, 105(12), pp.1384-1386.
9. **Belgrave D**, Henderson J, Simpson A, Buchan I, Bishop C, Custovic A 2016, Disaggregating asthma: big Investigation vs. big data, Journal of Allergy and Clinical Immunology, ISSN: 1097-6825
10. Holt PG, Strickland D, Bosco A, **Belgrave D**, Hales B, Simpson A, Hollams E, Holt B, Kusel M, Ahlstedt S, Sly PD, Custovic A. "Distinguishing benign from pathologic T H 2 immunity in atopic children." Journal of Allergy and Clinical Immunology. 137, no. 2 (2016): 379-387.
11. Mohammad, H.R., **Belgrave, D**., Kopec Harding, K., Murray, C.S., Simpson, A. and Custovic, A., 2016. Age, sex and the association between skin test responses and IgE titres with asthma. Pediatric Allergy and Immunology. Pediatric Allergy and Immunology (2016).
12. **Belgrave D**, Simpson A, Buchan I, Custovic A. Atopic dermatitis and respiratory allergy: what is the link. Current Dermatology Reports, 2015. http://dx.doi.org/10.1007/s13671-015-0121-6
13. Simpson A, Lazic N**, Belgrave D**, Johnson P, Bishop C, Mills, Custovic A. Patterns of IgE responses to multiple allergen components and clinical symptoms at age 11 years. J Allergy Clin Immunol. 2015 Apr 30. pii: S0091-6749(15)00432-7. doi: 10.1016/j.jaci.2015.03.027. [Epub ahead of print]
14. Custovic A, Sonntag HJ, Buchan IE, **Belgrave D**, Simpson A, Prosperi MC. Evolution pathways of IgE responses to grass and mite allergens throughout childhood. J Allergy Clin Immunol. 2015 May 8. pii: S0091-6749(15)00495-9. doi: 10.1016/j.jaci.2015.03.041. [Epub ahead of print]
15. Guerra S, Halonen M, Vasquez M, Spangenberg A, Stern DA, Morgan WJ, Wright AL, Lavi I, Tarès L, Carsin AE, Dobaño C, Barreiro E, Zock JP, Martínez-Moratalla J, Urrutia I, Sunyer J, Keidel D,

Imboden M, Probst-Hensch N, Hallberg J, Melén E, Wickman M, Bousquet J, **Belgrave DC** Simpson A, Custovic A, Antó J, Martinez F Relation between circulating CC16 concentrations, lung function, and development of chronic obstructive pulmonary disease across the lifespan: a prospective study. Lancet Respir Med, 2015(3):613-620

16. **Belgrave D**, Granell R, Simpson A, Guiver J, Bishop C, Buchan I, Henderson AJ, Custovic A. Developmental Profiles of Eczema, Wheeze, and Rhinitis: Two Population-Based Birth Cohort Studies. Plos Med 2014: 11(10), e1001748. doi: 10.1371/journal.pmed.1001748.

17. Brough H, Simpson A, Makinson K, Hankinson J, Brown S, Douiri A, **Belgrave D**, Penagos M, Stephens A, McLean W, Turcanu V, Nicolaou N, Custovic A, Lack G. "Peanut allergy: Effect of environmental peanut exposure in children with filaggrin loss-of-function mutations." J Allergy Clin Immunol. 2014 Oct;134(4):867-875.e1. doi: 10.1016/j.jaci.2014.08.011.

18. **Belgrave D**, Buchan I, Bishop C, Lowe L, Simpson A, & Custovic A. Trajectories of Lung Function During Childhood. Am J Respir Crit Care Med. 2014 May 1;189(9):1101-9. doi: 10.1164/rccm.201309-1700OC.

19. **Belgrave D**, Semic-Jusufagic A, Pickles A, Telcian AG, Bakhsoliani E, Sykes, Simpson A, Johnston SL, Custovic A. Assessing the association of early life antibiotic prescription with asthma exacerbations, impaired antiviral immunity, and genetic variants in 17q21: a population-based birth cohort study. Lancet Respir Med. 2014 Aug;2(8):621-30. doi: 10.1016/S2213-2600(14)70096-7.

20. **Belgrave D**, Simpson A, Custovic A. Challenges in interpreting wheeze phenotypes: The clinical implications of statistical learning techniques. Am J Respir Crit Care Med. 2014 Jan 15;189(2):121-3. doi: 10.1164/rccm.201312-2206ED.

21. Bonnelykke K, Sleiman P, Nielsen K, Kreiner-Moller E, Mercader JM, **Belgrave D**, den Dekker HT, Husby A, Sevelsted A, Faura-Tellez G, Mortensen LJ, Paternoster L, Flaaten R, Molgaard A, Smart DE, Thomsen PF, Rasmussen MA, Bonas-Guarch S, Holst C, Nohr EA, Yadav R, March ME, Blicher T, Lackie PM, Jaddoe VW, Simpson A, Holloway JW, Duijts L, Custovic A, Davies DE, Torrents D, Gupta R, Hollegaard MV, Hougaard DM, Hakonarson H, Bisgaard H. A genome-wide association study identifies cdhr3 as a susceptibility locus for early childhood asthma with severe exacerbations. Nat Genet. 2014 Jan;46(1):51-5. doi: 10.1038/ng.2830.

22. Sahiner UM, Semic-Jusufagic A, Curtin JA, Birben E, **Belgrave D**, Sackesen C, Simpson A, Yavuz TS, Akdis CA, Custovic A, Kalayci O. Polymorphisms of endotoxin pathway and endotoxin exposure: in vitro IgE synthesis and replication in a birth cohort. Allergy. 2014 Dec;69(12):1648-58. doi: 10.1111/all.12504. Epub 2014 Sep 20

23. Deliu M, **Belgrave D**, Simpson A, Murray CS, Kerry G, Custovic A. Impact of rhinitis on asthma severity in school-age children. Allergy. 2014 Nov;69(11):1515-21. doi: 10.1111/all.12467.

24. **Belgrave D**, Simpson A, Semic-Jusufagic A, Murray CS, Buchan I, Pickles A, Custovic A. Joint modeling of parentally reported and physician-confirmed wheeze identifies children with persistent troublesome wheezing. J Allergy Clin Immunol. 2013 Sep;132(3):575-583.e12. doi: 10.1016/j.jaci.2013.05.041.

25. **Belgrave D**, Custovic A, Simpson A. Characterizing wheeze phenotypes to identify endotypes of childhood asthma, and the implications for future management. Expert Rev Clin Immunol. 2013 Oct;9(10):921-36. doi: 10.1586/1744666X.2013.836450.

26. Wang R, Custovic A, Simpson A, **Belgrave D**, Lowe LA, Murray CS. Differing associations of BMI and body fat with asthma and lung function in children. Pediatr Pulmonol. 2014 Nov;49(11):1049-57. doi: 10.1002/ppul.22927.

27. Prosperi MC, Sahiner UM, **Belgrave D**, Sackesen C, Buchan IE, Simpson A, Yavuz TS, Kalayci O, Custovic A. Challenges in identifying asthma subgroups using unsupervised statistical learning techniques. Am J Respir Crit Care Med. 2013 Dec 1;188(11):1303-12. doi: 10.1164/rccm.201304-0694OC.

28. Prosperi MC, **Belgrave D**, Buchan I, Simpson A, Custovic A. Challenges in interpreting allergen microarrays in relation to clinical symptoms: A machine learning approach. Pediatr Allergy Immunol. 2014 Feb;25(1):71-9. doi: 10.1111/pai.12139.

29. Molter A, Agius RM, de Vocht F, Lindley S, Gerrard W, Lowe L, **Belgrave D**, Custovic A, Simpson A. Long-term exposure to pm10 and no2 in association with lung volume and airway resistance in the maas birth cohort. Environ Health Perspect. 2013 Oct;121(10):1232-8. doi: 10.1289/ehp.1205961.

30. Lazic N, Roberts G, Custovic A, **Belgrave D**, Bishop CM, Winn J, Curtin J, Hasan Arshad S, Simpson A. Multiple atopy phenotypes and their associations with asthma: similar findings from two birth cohorts. Allergy. 2013 Jun;68(6):764-70. doi: 10.1111/all.12134.

31. Curtin J, Simpson A, **Belgrave D**, Semic-Jusufagic A, Custovic A, Martinez F. Methylation of IL-2 promoter at birth alters the risk of asthma exacerbations during childhood. Clin Exp Allergy. 2013 Mar;43(3):304-11. doi: 10.1111/cea.12046.

32. Simpson A, Custovic A, Tepper R, Graves P, Stern DA, Jones M, Hankinson J, Curtin JA, Wu J, Blekic M, Bukvic BK, Aberle N, Marinho S, **Belgrave D**, Morgan WJ, Martinez FD. Genetic variation in vascular endothelial growth factor-a and lung function. Genetic Variation in Vascular Endothelial Growth Factor-A and Lung Function. Am J Respir Crit Care Med. 2012 Jun 1;185(11):1197-204. doi: 10.1164/rccm.201112-2191OC.

33. Nicolaou N, Murray C, **Belgrave D**, Poorafshar M, Simpson A, Custovic A. Quantification of specific IgE to whole peanut extract and peanut components in prediction of peanut allergy. J Allergy Clin Immunol. 2011 Mar;127(3):684-5. doi: 10.1016/j.jaci.2010.12.012

PROFESSIONAL BODIES AND SERVICES

- Area Chair NIPS 2018
- Advisory Board Deep Learning Indaba 2018-
- Reviewer UAI 2018
- Co-organiser AI in Healthcare: Key to better patient-practitioner-system partnerships - DALI Workshop 2018
- Scientific Committee Microsoft Research AI Summer School 2018
- Senior Program and Meeting Chair Women in Machine Learning 2017
- Program Committee Member Special Session on Machine Learning Applications in Psychiatric Research at The 17th IEEE International Conference on Machine Learning and Applications 2017
- Area Chair for Women in Machine Learning 2016
- Mentor for Women in Machine Learning 2016
- Member of the Royal Statistical Society
- Member of the European Academy of Allergy and Clinical Immunology
- Member of the American Academy of Allergy and Immunology
- Member of the British Society of Allergy and Clinical Immunology

INVITED PLENARY TALKS AND TUTORIALS

- Keynote: Machine Learning for Healthcare Conference, Stanford 2018
- Tutorial: Machine Learning for Personalised Health at ICML, Sweden 2018
- Keynote: Advances in Data Science, Manchester 2018
- Keynote: Women in Data Science Conference, Zurich 2018
- Invited Speaker: Columbia University, 2018
- Keynote: Big Challenges of Big Data – Spanish Allergy Society, Valencia 2018
- Tutorial: Machine Learning Strategies in Healthcare Research. Deep Learning Indaba, Johannesburg 2017
- A Bayesian Predictive Modelling Framework for Endotype Discovery. University of Manchester 2017
- Course Instructor at Health Informatics Conference: Machine Learning in Healthcare (Teaching with Prof Magnus Rattray) 2017
- Statistical Learning Approaches to Latent Variable Modelling to Accelerate Endotype Discovery. Systems Genomics Group, University of Melbourne, Australia 2016
- A Bayesian Approach to Compensating for Missing Data. Missing Data Methods Group, Murdoch Children's Research Institute, Australia 2016
- Centre for Epidemiology and Biostatistics, University of Melbourne, Australia 2016

- Invited Speaker at the 1st UK Prediction Modelling in Psychiatric Research Workshop, King's College London 2016
- Machine Learning to Understand Subtypes of Childhood Wheezing. International Congress on Pediatric Pulmonology, Naples 2016
- Workshop: Statistics for the Respiratory Pediatrician. International Congress on Pediatric Pulmonology, Naples 2016
- The Asthma E-Lab: Discovering Subtypes of Disease with Model-based Machine Learning. Royal Statistical Society Lancashire and East Cumbria, University of Lancaster 2016
- GlaxoSmithKline Biostatistics Annual Conference, London 2015
- Machine Learning and Perception Group, Microsoft Research Cambridge 2012
- Teaching Assistant:Generalized Linear Latent and Mixed Models. University of Oxford Spring School, Oxford 2010
- Course Assistant: Generalized Linear Latent and Mixed Models. 39th GESIS Spring Seminar: Testing and Modeling with Latent Variables, Cologne 2010