

4H Mathematical modelling of bad(?) behaviour

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According to an NHS website in January 2022 the cost of smoking to society is greater than 17 billion pounds for England each year. In march 2023 an NHS website published that ending smoking could free up 75,000 GP appointments each month. A UK Parliament website writes that alcohol costs the NHS 3.5 billion pounds per year in England, and costs 21 billion per year to society. If mathematical modelling can help reduce these costs this is clearly desirable.

Mathematical models for epidemics have traditionally been developed to analyse disease spread. However, a recent trend has been to employ the ODE models / ideas to topics of major social concern such as binge drinking, or illegal drug taking, or smoking, and recently the effect of smoking electronic cigarettes has been of major concern.

This project will look at classes of models for epidemic spread, cf. Hethcote [1]. The modelling involves either ordinary differential equations (ODEs) or partial differential equations (PDEs). You will study such concepts as stability of a solution, and possibly simulate a solution by computing it numerically. Computations can be done in any language you are comfortable with. Training in a computer language will not be given.

Prerequisites.

A willingness to work hard. Courses in Mathematical Biology or PDEs may help but are not essential.

Reading.

1. H.W. Hethcote. The mathematics of infectious diseases. *SIAM Review* 42 (2000), 599–653.
2. G. Mulone and B. Straughan. A note on heroin epidemics. *Math. Biosciences*, **218** (2009), 138–141.
3. G. Mulone and B. Straughan. Modelling binge drinking. *Int. J. Biomathematics*, **5** (2012), 1250005 (14 pages).
4. C.E. Walters, B. Straughan and J. Kendal. Modelling alcohol problems: total recovery. *Ricerche di Matematica*, **62** (2013), 33–53.
5. J.J. Bissell, C.C.D.S. Caiado, M. Goldstein and B. Straughan. Compartmental modelling of social dynamics with generalised peer incidence. *Math. Models Methods Appl. Sci.*, **24** (2014), 719–750.
6. J.J. Bissell, C.C.D.S. Caiado, S. Curtis, M. Goldstein and B. Straughan, editors. *Tipping points: modelling social problems and health*. Book in Wiley series in Computational and Quantitative Social Science (2015).
7. A. Giacobbe, G. Mulone, B. Straughan and W. Wang. Modelling drinking with information. *Mathematical Methods in Applied Science*, **40** (2017), 4400–4411.
8. J.H. Jung, A. Park, I.H. Jung. Qualitative and sensitivity analysis of the effect of electronic cigarettes on smoking cessation. *Computational and Mathematical Methods in Medicine*, (2018), 3738584.
9. B. Straughan. E-cigarette smoking with peer pressure. *Math. Meth. Appl. Science* 42 (6) (2019), 2098–2108.
10. A. Akgul, E.K. Akgul. Analysis of e-cigarette smoking model by a novel technique. *Methods of Mathematical Modelling - Infectious Diseases*.